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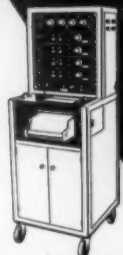
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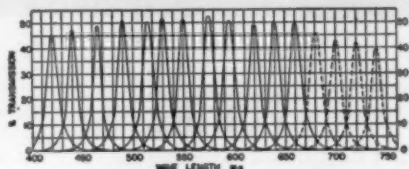
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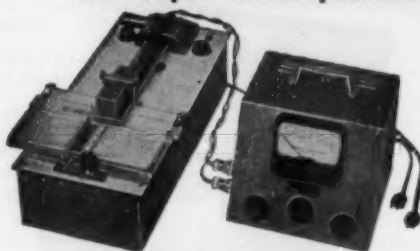
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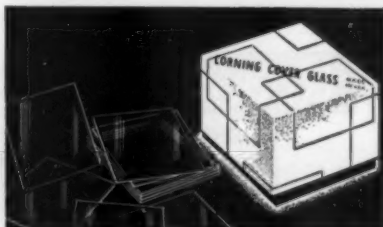
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# Development of the Acetylation Problem, a Personal Account\*

Fritz Lipmann

Biochemical Research Laboratory, Massachusetts General Hospital and  
Department of Biological Chemistry, Harvard Medical School, Boston, Massachusetts

THE fact that my Swedish colleagues have honored me with the Nobel prize gives me some confidence to consider my own effort more seriously as a part in the general effort of biochemistry of today. I therefore thought of tracing, in the segment of my interest, the recent development of facts and ideas which led, it seems, to a fuller understanding of the chemical functioning of the organism. When I started out in the middle twenties, biochemistry was just trying to break away from the major concern with breakdown processes and procedures. With the slowly increasing comprehension of biosynthetic mechanisms, a rather radical change of attitude ensued which is, I feel, not quite fully realized even at the present time. Out of the early, justifiably stubborn empiricism grew up a definite rational structure. Process patterns emerged and it became important to recognize certain rules and introduce new terms, thereby emphasizing the fact that biochemistry was now developing into an adult science, best characterized, maybe, as organismic technology.

In my development, the recognition of facts and the rationalization of these facts into a unified picture, have interplayed continuously. After my apprenticeship with Otto Meyerhof, a first interest on my own became the phenomenon we call the Pasteur effect, this peculiar depression of the wasteful fermentation in the respiring cell. By looking for a chemical explanation of this economy measure on the cellular level, I was prompted into a study of the mechanism of pyruvic acid oxidation, since it is at the pyruvic stage that respiration branches off from fermentation. For this study I chose as a promising system a relatively simple-looking pyruvic acid oxidation enzyme in a certain strain of *Lactobacillus delbrueckii* (1). The decision to explore this particular reaction started me on a rather continuous journey into partly virgin territory to meet with some unexpected discoveries but also to encounter quite a few nagging disappointments.

## Discovery of Acetyl Phosphate

The most important event during this whole period, I now feel, was the accidental observation that, in the *L. delbrueckii* system, pyruvic acid oxidation was com-

pletely dependent on the presence of inorganic phosphate. This observation was made in the course of attempts to replace oxygen by methylene blue. To measure the methylene blue reduction manometrically, I had to switch to a bicarbonate buffer instead of the otherwise routinely used phosphate. In bicarbonate, to my surprise, pyruvate oxidation was very slow, but the addition of a little phosphate caused a remarkable increase in rate (Fig. 1). Figure 2 shows the phos-

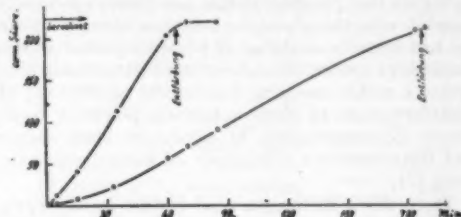


Fig. 1. Effect of phosphate on acid formation during the reduction of methylene blue. ●—● represents enough phosphate added to make a total concentration of  $4 \times 10^{-3}$  mole. ○—○ represents no phosphate.

phate effect more drastically. It represents use of a preparation from which all phosphate was removed by washing with acetate buffer. Then it appeared that the reaction was really fully dependent on phosphate.

In spite of such a phosphate dependence, the phosphate balance measured by the ordinary Fiske-Subbarow procedure did not at first indicate any phosphorylative step. Nevertheless, the suspicion remained that phosphate in some manner was entering into the reaction and that a phosphorylated intermediary was formed. As a first approximation, a coupling of this pyruvate oxidation with adenylic acid phosphorylation was attempted. And, indeed, addition of adenylic acid to the pyruvic oxidation system brought out a net disappearance of inorganic phosphate, accounted for as adenosine triphosphate (Table 1). In parallel with the then just developing fermentation picture, I concluded that the missing link in the reaction chain was acetyl phosphate. In partial confirmation it was shown that a crude preparation of acetyl phosphate, synthesized by the old method of Kämmerer and Carius (2) would transfer phosphate to adenylic acid (Table 2). However, it still took quite some time from then on to identify acetyl phosphate definitely as the initial product of pyruvic oxidation in this system (3, 4). Most im-

\* This paper is based on Dr. Lipmann's Nobel prize address delivered in Stockholm, Sweden, 11 Dec. 1953 when the 1953 award in medicine and physiology was made. It is published with permission of the Nobel Foundation and will also appear in *Les Prix Nobel 1953*.

Table 1. Disappearance of inorganic phosphate with adenylic acid.

	Initial value	0.125M pyruvate	0.125M Pyruvate 0.03M adenylic acid	0.03M adenylic acid
Inorganic P (mg)	0.59	0.53	0.31	0.59
Easily hydrolyzed P (mg)	0	0.06	0.28	0.01
O <sub>2</sub> (μlit)		490	474	58

portant during this and later work was the development of procedures (5) and in particular of the very handy hydroxamic acid method (6) for the determination of acyl phosphates and other reactive acyl derivatives.

At the time these observations were made, about a dozen years ago, there was, to say the least, a tendency to believe that phosphorylation was rather specifically coupled with the glycolytic reaction. Here, however, we had found a coupling of phosphorylation with a respiratory system. This observation immediately suggested a rather sweeping biochemical significance, of transformations of electron transfer potential, respiratory or fermentative, to phosphate bond energy and therefrom to a wide range of biosynthetic reactions (7).

There was a further unusual feature in this pyruvate oxidation system in that the product emerging from the process not only carried an energy-rich phosphoryl radical such as was already known, but the acetyl phosphate was even more impressive through its energy-rich acetyl. It rather naturally became a contender for the role of "active" acetate, for the widespread existence of which the isotope experience had already furnished extensive evidence. I became, therefore, quite attracted by the possibility that acetyl phosphate could serve two rather different purposes, either to transfer its phosphoryl group into the phosphate pool, or to supply its active acetyl for biosynthesis of carbon structures. Thus acetyl phosphate should be able to serve as acetyl donor as well as phosphoryl donor, transferring, as is shown in Fig. 3, on each side of the oxygen center, such as indicated by Bentley's early experiments on cleavage of acetyl phosphate in H<sub>2</sub>O<sup>18</sup> (7a).

Table 2. Transfer of phosphate from acetyl phosphate to adenylic acid with bacterial preparations. Fresh solution, containing 0.75 mg acid-labile P in 0.5 ml, 46 mg dry bacteria, total volume 1.25 ml, with 0.04M in NaF.

Adenylic acid (mg)	4	0.1	
Inorganic P, inorg. + labile (acetyl P) (mg)	1.12	1.39	1.37
P, after 7 min hydrolysis at 100°C in normal HCl (mg)	1.47	1.48	1.47
P <sub>i</sub> formed (mg)	0.35	0.09	0.10

These two novel aspects of the energy problem, namely (i) the emergence of an energy-rich phosphate bond from a purely respiratory reaction, and (ii) the presumed derivation of a metabolic building-block through this same reaction, prompted me not only to propose the generalization of the phosphate bond as a versatile energy-distributing system but also to aim from there toward a general concept of transfer of activated groupings by carrier as the fundamental reaction in biosynthesis (8, 9). Although in the related manner the appearance of acetyl phosphate as a metabolic intermediary first focused attention to possible mechanisms for the metabolic elaboration of group activation, it soon turned out that the relationship between acetyl phosphate and acetyl transfer was much more complicated than anticipated.

Since a better understanding of the mechanisms of group activation seemed to become a most urgent problem in biosynthesis, I now set out to find a suitable system to check on the assumption that acetyl phosphate represented active acetate. After working out a relatively easy method to prepare the compound (5, 10), a first unexpected difficulty arose when it appeared that animal tissues contain rather generally a very active, specific, and heat-stable acetyl phosphatase (9, 11). In crude preparations of muscle, liver, and other tissues, the half-life of acetyl phosphate is only a few minutes. This strange activity in animal

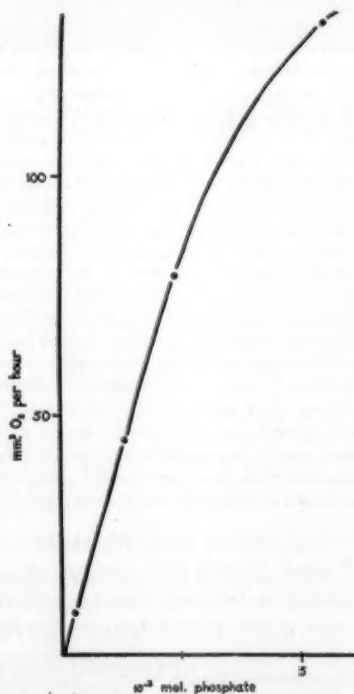


Fig. 2. Phosphate-dependence of pyruvate oxidation.



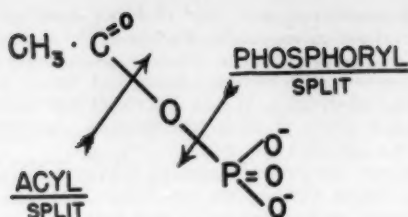


Fig. 3. Acetyl phosphate.

tissues made tests with this substance very difficult.

In looking for a sensitive method to study acetyl transfer, the acetylation of aromatic amines was chosen eventually as a most promising and technically easy procedure. We were, furthermore, quite confident that any results obtained with this method could be generalized over the whole metabolic territory concerning the transfer of active acetate, including such reactions as citrate, acetoacetate, and lipid synthesis. Acetylation of sulfonamide had been found to occur in rabbit liver slices (12, 13). However, for our purposes, we had to eliminate cell membrane barriers to test for the activity of complex intermediary metabolites. Although acetylation was found with rabbit liver homogenate, the reaction was rather weak. In search of a more active system, pigeon liver homogenate was tried and found to harbor an exceedingly potent acetylation system (11, 12). This finding of a particularly active acetylation reaction in cell-free pigeon liver preparations was most fortunate and played a quite important part in the development of the acetylation problem.

We had eventually arrived at the point where the desired test for acetyl phosphate as an acetyl precursor could be performed. Although the acetyl phosphatase activity of the pigeon liver homogenate was considerable and, to some extent, obscured the test with acetyl phosphate, it became, nevertheless, clear to us that in this preparation, acetyl phosphate did not furnish active acetate (11). Under anaerobic conditions the massive concentrations of acetyl phosphate, no acetyl groups for the acetylation of sulfonamide could be derived under conditions where an easy acetylation occurred with a respiring homogenate.

It furthermore appeared that, as an energy source, the particle-bound oxidative phosphorylation of the kind observed first by Herman Kalckar (14) could be replaced by ATP, as had first been observed with the acetylation of choline in brain preparations by Nachmansohn and his group (15, 16). Using ATP and acetate as precursors, it was possible to set up a homogenous particle-free acetylation system obtained by extraction of acetone pigeon liver. In this extract likewise acetyl phosphate was unable to replace the ATP-acetate as acetyl precursor.

#### Discovery and Identification of Coenzyme A

In spite of this disappointment with acetyl phosphate, our decision to turn to a study of acetylation

started then to be rewarding in another way. During these studies we became aware of the participation of a heat-stable factor which disappeared from our enzyme extracts on aging or dialysis. This cofactor was present in boiled extracts of all organs as well as in microorganisms and yeast. It could not be replaced by any other known cofactor. Therefore, it was suspected that we were dealing with a new coenzyme. From then on, for a number of years, the isolation and identification of this coenzyme became the prominent task of our laboratory. The problem now increased in volume, and it was my good fortune that a group of exceedingly able people were attracted to the laboratory; first Constance Tuttle, then Nathan O. Kaplan, and shortly afterward G. David Novelli. More recently, Morris Soodak and John Gregory and quite a few others have made here most important contributions to the advance of this problem.

Table 3. Reversible inactivation through dialysis or autolysis; 1 ml of extract in a total volume of 2 ml; magnesium chloride and sodium acetate were present in 0.02M concentration. The experiment was started through addition of a mixture of 0.32 mg of adenylyl polyphosphate P, 88 µg of sulfanilamide, and fluoride to 0.05M final concentration.

Treatment of extract	Filtrate of boiled organ added, corresponding to fresh weight	Sulfanilamide conjugated (µg)	Incubation time (min)
Untreated		69	65
Kept 16 hr, 7°C		7	40
	0.2 g rat liver	58	
Dialyzed 16 hr, 7°C		0	65
	0.2 g rat liver	42	
Untreated		59	50
Kept 16 hr, 7° to 10°C		0	
	0.4 g rat liver	28	

Early data on the replacement of this heat-stable factor by boiled extracts are shown in Table 3. The pigeon liver acetylation system proved to be a very convenient assay system for the new coenzyme (17), since on aging for 4 hr at room temperature, the cofactor was completely autolyzed. Fortunately, on the other hand, the enzyme responsible for the decomposition of this factor was quite unstable and faded out during the aging, while the acetylation apoenzymes were unaffected.

Figure 4 shows coenzyme A (CoA) assay curves obtained with acetone pigeon liver extract. Finding pig liver a good source for the coenzyme, we set out to collect a reasonably large quantity of a highly purified preparation and then to concentrate on the chemistry with this material. In this analysis we paid particular attention to the possibility of finding in this obviously novel cofactor one of the vitamins, then not as yet metabolically identified. In this task we



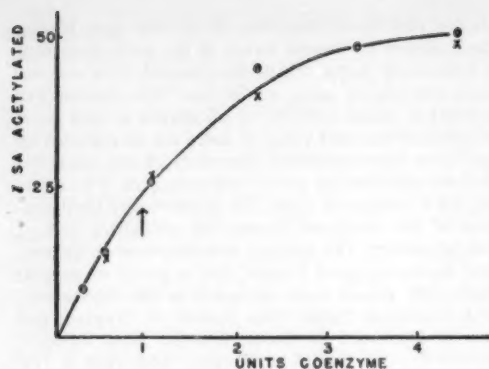


Fig. 4. Concentration-activity curves for coenzyme-A preparations of different purity. The arrow indicates the point of 1 unit on the curve. Ordinate scale, sulfanilamide acetylated.  $\circ$  represents crude coenzyme, 0.25 units/mg;  $\times$  represents purified coenzyme, 130 units/mg.

were very fortunate to have the help of the great experience of Roger Williams' laboratory. Beverly Guirard, who occupied herself with this preparation, at first seemed not to find any appreciable amounts of the known vitamins. However, she became aware of the fact that on prolonged enzymatic treatment, the value of pantothenic acid, as determined microbiologically, did slightly increase. This gave the hint that the coenzyme may not release the pantothenic acid so easily, a fact well known from experience with pantothenic acid assay in tissue extracts. In confirmation, she found on acid hydrolysis of the coenzyme, considerable amounts of  $\beta$ -alanine, corresponding to 11 percent of pantothenic acid in this preparation which, as we now know, was 40-percent pure. The results of Guirard's vitamin survey, which gave us the practical assurance of the presence of pantothenic acid in the new coenzyme (18), are shown in Table 4.

The appearance of a B vitamin in the preparation was, of course, a most exciting event for our group and gave us further confidence that we were dealing here with a key substance. We still felt, however, slightly dissatisfied with the proof for pantothenic acid. Therefore, to liberate the chemically rather un-

stable pantothenic acid from CoA, we made use of observations on enzymatic cleavage of the coenzyme. Two enzyme preparations, intestinal phosphatase and an enzyme in pigeon liver extract, had caused independent inactivation. It then was found that through combined action of these two enzymes, pantothenic acid was liberated (18, 19).

The two independent enzymatic cleavages indicated early that in CoA existed two independent sites of attachment to the pantothenic acid molecule. One of these obviously was a phosphate link, linking presumably to one of the hydroxyl groups in pantothenic acid. The other moiety attached to pantothenic acid, which cleaved off by liver enzyme, remained unidentified for a long time. In addition to pantothenic acid, our sample of 40-percent purity had been found to contain about 2 percent sulfur by elementary analysis and identified by cyanide-nitroprusside test as a potential SH-grouping (20, 21). Furthermore, the coenzyme preparation contained large amounts of adenylic acid (21).

In the subsequent elaboration of the structure, the indications by enzyme analysis for the two sites of attachment to pantothenic acid have been most helpful. The phosphate link was soon identified as a pyrophosphate bridge (22). 5-Adenylic acid was identified by Novelli (23) as an enzymatic split product and by Baddiley (24), through chemical cleavage. At the same time, Novelli made observations that indicated the presence of a third phosphate in addition to the pyrophosphate bridge. These indications were confirmed by analysis of a nearly pure preparation that was obtained by Gregory (25) from *Streptomyces fradiae* in collaboration with the research group at the Upjohn Company (26). The generous help of the Upjohn Laboratories has been of great importance for the final identification of the structure of CoA. The analysis of this practically pure preparation is presented in Table 5.

It was at this period that we started to pay more and more attention to the sulfur in the coenzyme. As is shown in Table 5, our purest preparation contained 4.3 percent sulfur corresponding to 1 mole per mole of pantothenate. We also found (26) that dephosphorylation of CoA yielded a compound containing pantothenic acid and the sulfur-carrying moiety, which

Table 4. Vitamin content of preparation A.

Vitamin	Percentage
Nicotinic acid	0.06
Folic acid	.0002
Riboflavin	.006
Inositol	.05
Pyridoxine	.03
Biotin, thiamine	Not detectable
Pantothenic acid	
Direct	.085
1 wk incubated with papain-clarase	.16
From $\beta$ -alanine, after acid hydrolysis	11.0

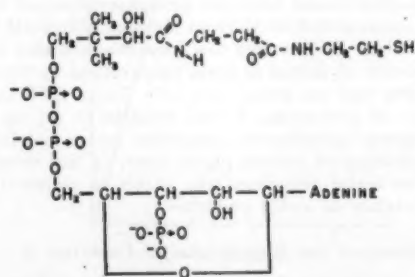


Fig. 5. Structure of coenzyme A.

Table 5. Composition of best preparation of CoA.

	Calcd. (%) <sup>a</sup>	Found (%)	Ratio
Pantothenic acid	28.6	26.8 (enzymatic assay)	1
		25.6 (microbiological)	
Adenine	17.6	17.0 (spectrophotometric)	1.05
Phosphorus (total)	12.12	10.6	2.83
Monocester phosphorus†		3.6	0.96
Sulfur	4.18	4.13	1.07

<sup>a</sup> Pantothenic acid, 2-mercaptoethylamine, 3 phosphoric acid, adenosine, -5H<sub>2</sub>O; molecular weight 767.

† Liberated by prostate phosphomonoesterase.

we suspected as bound through the carboxyl. Through the work of Snell and his group (27), the sulfur-containing moiety proved to be attached to pantothenic acid through a link broken by our liver enzyme. It was identified as thioethanolamine by Snell and his group, linked peptidically to pantothenic acid.

Through analysis and synthesis, Baddiley now identified the point of attachment of the phosphate bridge to pantothenic acid in 4-position (24), and Novelli *et al.* (28) completed the structure analysis by enzymatic synthesis of "dephospho-CoA" from pantotheine-4'-phosphate and ATP. Furthermore, the attachment of the third phosphate was identified by Kaplan (29) to attach in 3-position on the ribose of

the 5-adenylic acid (whereas in triphosphopyridine nucleotide it happens to be in 2-position). Therefore, the structure was now established (Fig. 5).

#### Metabolic Function of CoA

Parallel with this slow but steady elaboration of the structure, all the time we explored intensively metabolic mechanisms in the acetylation field. By use of the enzymatic assay, as is shown in Tables 6, 7, and 8, CoA was found present in all living cells, animals, plants, and microorganisms (17). Furthermore, the finding that all cellular pantothenic acid could be accounted for by CoA (17), made it clear that CoA represented the only functional form of this vitamin. The finding of the vitamin furnished great impetus; nevertheless, a temptation to connect the pantothenic acid with the acetyl transfer function blinded us for a long time to other possibilities.

The first attempts to explore further the function of CoA were made with pantothenic acid-deficient cells and tissues. A deficiency of pyruvate oxidation in pantothenic acid-deficient *Proteus morganii*, an early isolated observation by Dorfman (30) and Hills (31), now fitted rather well into the picture. We soon became quite interested in this effect, taking it as an indication for participation of CoA in citric acid synthesis. A parallel between CoA levels and pyruvate oxidation in *P. morganii* was demonstrated (32). Using pantothenic acid-deficient yeast, Novelli *et al.* (33) demonstrated a CoA-dependence of acetate oxidation (Fig. 6) and Olson and Kaplan (34) found with duck liver a striking parallel between CoA content and pyruvic utilization, which is shown in Fig. 7.

But more important information was being gathered on the enzymatic level. The first example of a generality of function was obtained by comparing the acti-

Table 6. Coenzyme A in animal tissues. All values are given in units of coenzyme A per gram of fresh tissue.

	Human	Rabbit	Rat	Pigeon
Liver	112		132	105
Adrenal	65		91	
Adrenal demedullated			79	
Kidney	50		74	
Brain	40 (cortex)		28	40
Heart	26		42	45
Testes	26			
Intestine			26	
Thymus			20	
Skeletal muscle		6		
Blood plasma	0			
Red blood cells	3-4			

Table 7. Coenzyme A in microorganisms.

Microorganism	Coenzyme A per gram dry weight (units)	Preparation used for assay
<i>Proteus morganii</i>	572	Freshly grown organism, boiled
<i>Lactobacillus arabinosus</i>	150	
<i>Lactobacillus delbrueckii</i>	40	Dry preparation, suspended in water and boiled
Tray-dried yeast	72	
Tray-dried yeast	41	
<i>Escherichia coli</i>	320	
Propionic acid bacteria	330	
<i>Clostridium butylicum</i> (dried extract)	2000	

Table 8. Coenzyme A in plant material.

	Coenzyme A per gram fresh weight (units)
Spinach	0.74
Tomato	1.3
Frozen pens	4.5
Wheat germ (commercial sample)	30
Royal jelly (bee)	0

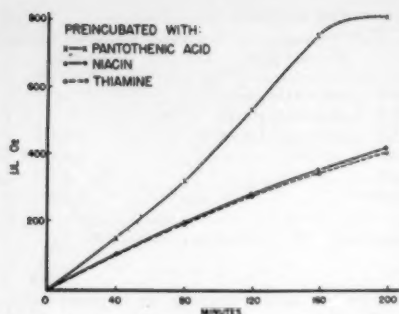


Fig. 6. Effect of coenzyme A on acetate oxidation in yeast.

vation of apoenzymes for choline and sulfonamide acetylation, respectively, using our highly purified preparations of CoA (9). As is shown in Fig. 8, similar activation curves obtained for the two respective enzymes. Through these experiments, the heat-stable factor for choline acetylation that had been found by Nachmansohn and Behrman (35) and by Feldberg and Mann (36) was identified with CoA.

The next most significant step toward a generalization of CoA function for acetyl transfer was made by demonstrating its functioning in the enzymatic synthesis of acetoacetate. The CoA effect in acetoacetate

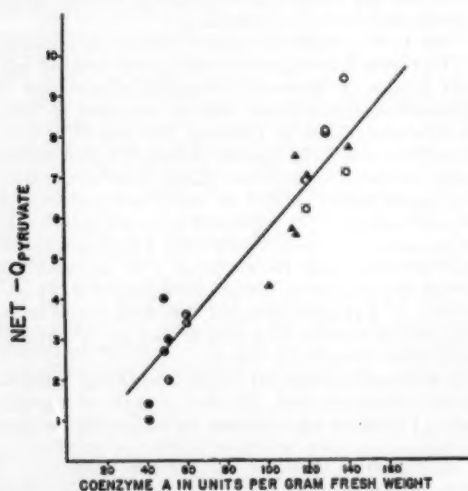


Fig. 7. Relationship between net pyruvate utilization (net- $Q_{\text{pyruvate}}$ ) and coenzyme-A content of liver slices from deficient, pantothenic acid-treated, and normal ducks. Net- $Q_{\text{pyruvate}}$  values for individual liver slices are plotted against their respective coenzyme-A values in units per gram of fresh weight of slice. ● represents deficient; ●, deficient treated *in vitro*; ▲ deficient treated *in vivo* by intraperitoneal injection of 10 mg of calcium pantothenate per 100 g of body weight 1 to 2 hr before observation; ○ normal controls fed *ad libitum*.

synthesis was studied by Morris Soodak (37), who obtained for this reaction a reactivation curve quite similar to the curves for enzymatic acetylation (Fig. 9). Soon afterwards Stern and Ochoa (38) showed a CoA-dependent citrate synthesis with a pigeon liver fraction similar to the one used by Soodak for acetoacetate synthesis. In our laboratory, Novelli *et al.* confirmed and extended this observation with extracts of *Escherichia coli* (39).

In the course of this work, which more and more clearly defined the acetyl transfer function of CoA, Novelli once more tried acetyl phosphate. To our surprise and satisfaction, it then appeared, as is shown in Table 9, that in *E. coli* extracts, in contrast to the animal tissue, acetyl phosphate as acetyl donor for citrate synthesis was more than twice as active as ATP-acetate (39). Acetyl phosphate, therefore, functioned as a potent microbial acetyl donor. Acetyl transfer from acetyl phosphate, like that from ATP-acetate, was CoA-dependent, as is shown in Table 9. Furthermore, a small amount of "microbial conversion factor," as we called it first, primed acetyl phosphate for activity with pigeon liver acetylation systems, as is shown

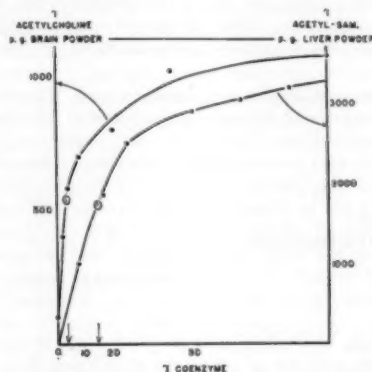


Fig. 8. Activation curves for acetocholekinase and acetoarylaminekinase by purified coenzyme-A preparations.

Table 9. Citric acid synthesis in dialyzed extract of *E. coli*. All tubes contained 1.0 ml of extract, 0.025M oxalacetic acid, 0.016M  $\text{NaHCO}_3$ , 0.02M  $\text{MgCl}_2$ , and 0.01M cysteine in a final volume of 2.5 ml. The concentrations of the additions were as follows: sodium acetate 0.05M, sodium ATP 0.02M, lithium acetyl phosphate 0.004M, and coenzyme A 17 units.

Additions	Citric acid synthesized per milliliter extract ( $\mu\text{M}$ )
None	0
Acetate, ATP	0.23
Acetate, ATP coenzyme A	1.30
Acetyl phosphate	0.25
Acetyl phosphate coenzyme A	4.0

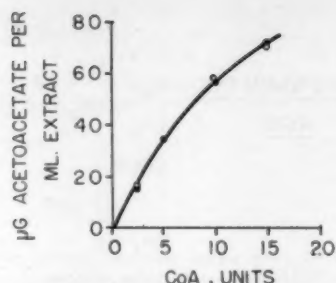


Fig. 9. Coenzyme-A-dependence of acetoacetate formation from acetate plus ATP with ammonium sulfate pigeon liver fraction.

in Table 10 (40). Eventually the microbial conversion factor was identified by Stadtman *et al.* (40) with the transacetylase first encountered by Stadtman and Barker in extracts of *Clostridium kluveri* (41) and likewise, although not clearly defined as such, in extracts of *E. coli* and *C. butylicum* by Lipmann and Tuttle (42).

The definition of such a function was based on the work of Doudoroff *et al.* (43) on transglucosidation with sucrose phosphorylase. Their imaginative use of isotope exchange for closer definition of enzyme mechanisms has been most influential. Like glucose-1-phosphate with sucrose phosphorylase, acetyl phosphate with these various microbial preparations equilibrates its phosphate rapidly with the inorganic phosphate of the solution. As in the Doudoroff *et al.* experiments, first a covalent substrate enzyme derivative had been proposed (43). However, then Stadtman *et al.* (40), with the new experience of CoA-dependent acetyl transfer, could implicate CoA in this equilibration between acetyl- and inorganic phosphate and thus could define the transacetylase as an enzyme equilibrating acetyl between phosphate and CoA:

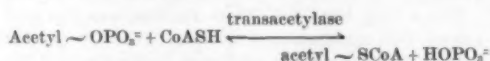


Table 10. Acetylation of p-aminobenzoic acid (PABA) by pigeon liver enzyme, acetyl phosphate, and *C. kluveri* extract. Conditions, tris(hydroxymethyl)aminomethane buffer (pH 8.1), 0.2M; cysteine, 0.01M; acetyl ~ P, 0.025M; PABA, 0.001M; CoA (67 units per milligram), 10 units; bacterial transacetylase (acid ammonium sulfate fraction, 43 to 86 percent saturation), 0.3 mg; pigeon liver fraction (A-60-4), 0.3 ml. Final volume 1.0 ml, 28°, 60 min.

System	Acetyl PABA, Bratton and Marshall (µM)
Acetyl ~ P + liver fraction, A-60	0
Acetyl ~ P + transacetylase	0
Transacetylase + liver fraction	0
Acetyl ~ P + liver fraction + bacterial transacetylase	0.92

In the course of these various observations, it became quite clear that there existed in cellular metabolism an acetyl distribution system centering around CoA as the acetyl carrier that was rather similar to the ATP-centered phosphoryl distribution system. The general pattern of group transfer became recognizable, with donor and acceptor enzymes being connected through the  $\text{CoA} \longleftrightarrow \text{acetyl CoA}$  shuttle.

A clearer definition of the donor-acceptor enzyme scheme was obtained through acetone fractionation of our standard system for acetylation of sulfonamide into two separate enzyme fractions, which were inactive separately but showed the acetylation effect when combined. A fraction, A-40, separating out with 40 percent acetone, was shown by Chou (44) to contain the donor enzyme responsible for the ATP-CoA-acetate reaction, whereas with more acetone, the acceptor function, A-60, precipitated the acetoarylaminekinase, as we propose to call this type of enzyme. The need for a combination of the two for over-all acetyl transfer is shown in Fig. 10. This showed that a separate sys-

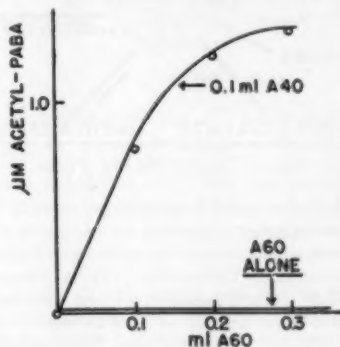
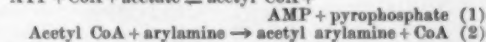


Fig. 10. Acetylation of p-aminobenzoic acid (PABA) with fractions A-40 and A-60 added in various proportions.

tem was responsible for acetyl CoA formation through interaction of ATP, CoA, and acetate (see later) and that the over-all acetylation was a two-step reaction:



Acetyl CoA + arylamine  $\rightarrow$  acetyl arylamine + CoA (2)

These observations crystallized into the definition of a metabolic acetyl transfer territory as pictured in Fig. 11.

This picture had developed from the growing understanding of enzymatic interplay involving metabolic generation of acyl CoA and transfer of the active acyl to various acceptor systems. A most important, then still missing link in the picture was supplied through the brilliant work of Feodor Lynen (45) who chemically identified acetyl CoA as the thioester of CoA. Therewith the thioester link was introduced as a new energy-rich bond, and this discovery added a very novel facet to our understanding of the mechanisms of metabolic energy transformation.

### Carboxyl and Methyl Activation in Acetyl CoA

In spite of many similarities between the general aspects of group transfer involving phosphoryl and acetyl groupings, there is a considerable difference insofar as the grouping transferred in the acetyl territory is an organic grouping and displays a quite different versatility for condensation reactions, yielding eventually large and complex carbon structures. There is one feature in this picture that always has attracted our particular attention: the twofold type of activation involving (i) the carboxyl end, or the "head," of the acetyl and (ii) its methyl, or "tail," end.

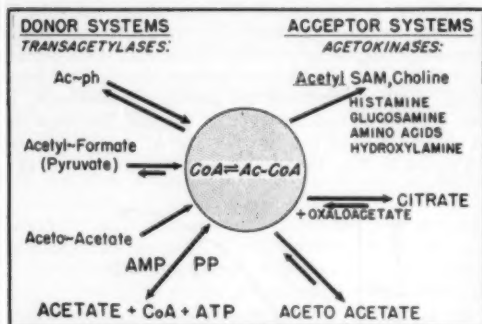


Fig. 11. Acetyl transfer scheme.

The definition of the head reaction is relatively simple. Acetylation of arylamine or choline is a typical head reaction. There is to be mentioned, furthermore, the observation by Chantrenne (46), introducing CoA as a rather general catalyst of acyl activation. He demonstrated the activity of CoA in benzoyl transfer such as hippuric acid synthesis. The mechanism of this synthesis was elaborated recently by Taggart (47), who clearly defined benzoyl CoA as the benzoyl donor in this reaction. An even greater and more prominent generalization is offered through the more and more developing importance of succinyl CoA in intermediary metabolism.

The second type, the methyl, or tail, activation, is

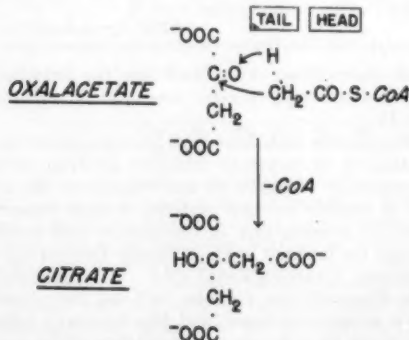


Fig. 12. Tail reaction: citric acid synthesis.

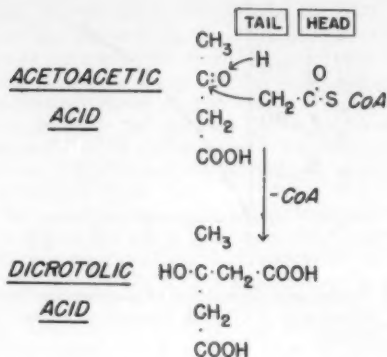
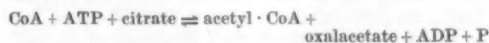


Fig. 13. Tail reaction: synthesis of  $\beta$ -hydroxy,  $\beta$ -methyl glutaric acid (dicrotolic acid). Note the similarity to citric acid synthesis.

not as well understood. In citric acid synthesis, as may be seen from Fig. 12, the methyl end engages in an aldolase type of condensation with the carbonyl group of the oxaloacetate as acceptor. This condensation requires an energy input that must be derived from the thioester link, and at the end of the reaction CoA appears to be liberated in some manner.

The complexity of the citrate condensation is emphasized through the existence of an ATP-CoA-citrate reaction recently observed by Srere *et al.* (48), which results in the disruption of citrate to oxaloacetate and acetyl CoA.



The mechanism remains still to be understood in greater detail. The reaction is mentioned here because it introduced the new variety into the citric acid cycle through a conversion of phosphoryl via citrate into acetyl.

For a long time the citrate reaction was the only known tail condensation. However, recently another interesting example has developed in the study of the precursors in steroid and isoprene synthesis. The initial condensation product in this series appears to be  $\beta$ -methyl,  $\beta$ -hydroxyglutarate (dicrotolic acid), formed through condensation of acetoacetate with acetyl CoA. The striking analogy between this and the citrate condensation appears in Fig. 13. This initial condensation seems to be followed by decarboxylation and dehydration to  $\beta$ -methyl crotonic acid first demonstrated by Bonner *et al.* (49) as intermediary in rubber synthesis.

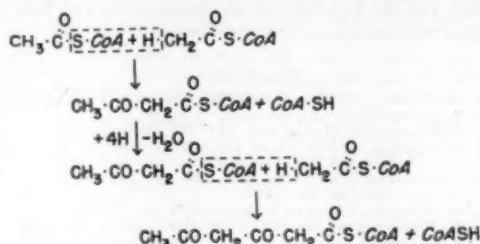
In a third type, a combination of head and tail reaction takes place with two acyl CoA's reacting with each other in a head-to-tail condensation. When studying acetoacetate synthesis, we were at first not quite aware of its belonging to this third type of reaction. The calculation of the energy required had yielded a figure of around 15 kilocalories which could be covered by one energy-rich bond (9). However, by using as



Table 11. Synthesis of acetoacetate from  $\text{CH}_3\text{C}^{14}\text{OPO}_3^-$ 

	Start	End
	(counts per min, per $\mu\text{M}$ )	
Acetate	0	2,900
Acetyl phosphate	23,000	22,400
Acetoacetate		35,200
Carboxyl-C		15,700
Carbonyl-C		19,500

acetyl donor carboxyl-labeled acetyl phosphate, fed through transacetylase, the marker appeared in the carbonyl, as well as the carboxyl, part of acetoacetate (Table 11). This demonstrated a head-tail character for the reaction. The finer mechanism of this reaction between two acetyl CoA's, as shown in Fig. 14, has



#### AND REPEAT....

Fig. 14. Head-to-tail condensation: acetoacetate synthesis and follow reactions in straight-chain fatty acid synthesis.

been more recently elaborated in particular by Lynen's group (50), by Green's laboratory (51) and by Ochoa and his group (52). Presumably in the building up of longer terpene chains, a head-tail condensation may occur between two  $\beta$ -methyl crotonyl CoA's, followed by hydrogenation and dehydration (Fig. 15).

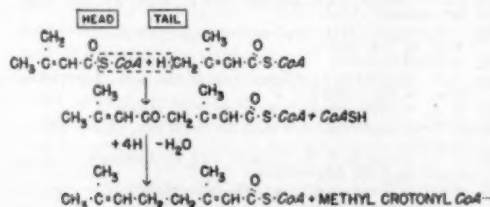
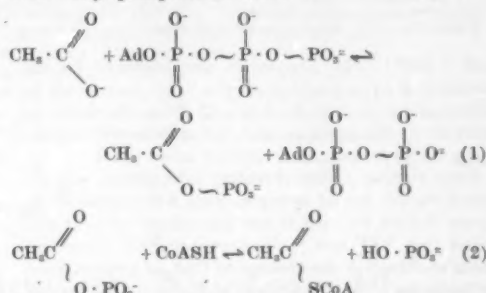


Fig. 15. Tentative scheme for terpene synthesis: head-to-tail condensation of methyl-crotonyl CoA's.

A quite new type of head-tail condensation, presumably between succinyl CoA and glycol CoA was recently suggested by Shemin's work on heme synthesis (53). The thus primarily formed keto, amino dicarboxylic acid then appears to be decarboxylated to  $\delta$ -amino levulinic acid. Shemin synthesized the latter marked with  $\text{C}^{14}$  and showed its incorporation into the heme molecule.

#### Mechanism of ATP-CoA-Acetate Reaction

In the recent past we have been mostly occupied with the mechanism through which the phosphate bond in ATP converts to acetyl bond in acetyl CoA. In animal tissue where acetyl phosphate appeared not to be an intermediate, the conversion mechanism remained very puzzling for a long time. Before considering this reaction, it will be advantageous to review first the microbiological mechanism of such interconversion and in particular the role of acetyl phosphate as an intermediary. This transformation is rather straightforward: a sequence of two independent enzymatic reactions, the first a transphosphorylation from ATP to acetate and the second, as discussed, a transacylation from acetyl phosphate to CoA:



It should be noted that in the first transphosphorylation step the acetyl phosphate cleaves and condenses between O and P. In the second transacylation reaction, however, acetyl phosphate cleaves and condenses between carbon C and O. Thus the same molecule reacts on each side of the oxygen bridge between the carbon and the phosphorus. This shift of the site of cleavage in the sequence is significant. This possibility attracted my early attention (see Fig. 3) and was one of the reasons that prompted me into this whole exploration. A shift from  $\text{P}-\text{OC}$  to  $\text{PO}-\text{C}$  should actually be a feature of many condensations initiated by a phosphoryl split from ATP. These become increasingly numerous, such as in glutamine, glutathione, pantothenate, and seemingly in protein synthesis.

The finer mechanism generally is obscured by enzyme-bound steps. In all these reactions, however, somewhere along the line a shift from transphosphorylation to transacylation seems to be inherent. This shift stands out very clearly in the microbial two-step reaction. But in animal tissue, the energy transmission from phosphoryl to acetyl occurs through a continuous enzyme-bound reaction chain which is more difficult to elucidate. Nevertheless, some progress has been made, which also starts to reflect on other mechanisms of this type.

Jones *et al.* (54, 55, 56) have explored the reaction with liver and with yeast, and a surprising feature was uncovered, namely, that the initial phosphoryl split of ATP occurs between pyrophosphoryl group and AMP. The cleavage products of ATP were identified as inorganic pyrophosphate (PP) and adenylic

Table 12. Effect of fluoride on pyrophosphate formation. Each vessel contained in 1 ml: 12  $\mu$ M ATP; 10  $\mu$ M potassium acetate; 10  $\mu$ M  $MgCl_2$ ; 20  $\mu$ M  $H_2S$ ; 200  $\mu$ M tris(hydroxymethyl)aminomethane buffer, pH 7.5 and 0.02 ml (20 units) of yeast enzyme fraction 4. Vessels were incubated at 37°C for 30 min.

Fluoride added ( $\mu$ M/ml)	CoA* added ( $\mu$ M/ml)	Acetyl CoA ( $\mu$ M/ml)	PP ( $\mu$ M/ml)	Pi ( $\mu$ M/ml)
0	0	0	0	7.4
0	2.9	2.72	0	13.2
50	0	0	0	1.75
50	2.9	2.88	3.10† 3.16‡	2.10

\* 1  $\mu$ M CoA = 310 units.

† Determined by color increase.

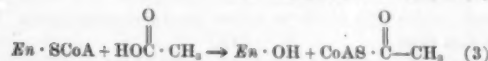
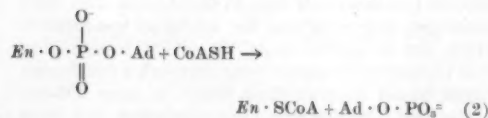
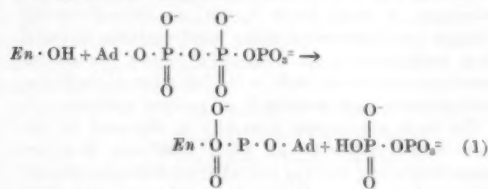
‡ Determination by Mn precipitation method.

acid (AMP). The mechanism was obscured by the presence of pyrophosphatase which, however, could be suppressed with fluoride. Table 12 shows the course of reaction in the presence and the absence of fluoride, using the hydroxamate formation as an index.

Some further rather revealing information was obtained by the use of isotopes. This was suggested by Lynen during his visit to our laboratory (50). It was found that ATP and radioactive inorganic pyrophosphate exchange in the absence of CoA or acetate. Such an exchange is best compatible with an initial reaction between the enzyme and ATP, resulting in a covalent binding of AMP to the enzyme, E,



It furthermore was found that acetyl CoA exchanges with radioactive free acetate in the absence of ATP or pyrophosphate. This exchange would indicate an exchange of acetyl for enzyme in the final step. Therefore, an over-all sequence (En standing for enzyme) was proposed as follows:



The middle step—that is, the substitution of enzyme-bound AMP by CoA—is the most problematic but also the most interesting one, since it may foreshadow mechanisms implicating nucleotide activation for polynucleotide formation. No indications were found for

the identity of the grouping on the enzyme through which the initial binding of AMP and further exchange with CoA might occur. A further purification of the enzyme would be necessary before obtaining fuller information.

A pyrophosphoryl split of ATP also was found by Maas (57, 58) to initiate pantothenate synthesis. The isotope exchange picture with this synthesis is somewhat different. It indicates in some manner a phosphorylative priming for peptidic synthesis and has been very tentatively used as a start for developing possible schemes for polypeptide synthesis (59).

Altogether, in this area, a diversified picture is rapidly developing. There is good reason to hope that in the not too distant future, out of the fair confusion of the present, a clearer understanding will eventually evolve. A new level of complexity seems slowly to unravel, and the gap between the biochemical and biological approach is narrowing down.

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*This morning, looking out of our window, I was deeply moved to see that the flags had come out to honor men whose only claim to fame may seem that they succeeded in finding answers to some of the mysteries of nature. Their purpose often may be none but just to push back a little the limits of our comprehension. Their findings mostly have to be expressed in a scientific language that is understood by only a few. We feel, nevertheless, that the drive and urge to explore nature in all its facets is one of the most important functions of humanity. To make the general public truly aware of such seems to me one of the great achievements of the Nobel Institution.—[Remarks by Fritz Lipmann at the Nobel banquet, 10 Dec. 1953. See page 855.]*

## International Conference on Nuclear Physics in Glasgow

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**A**BOUT 300 physicists representing some 20 countries attended an international conference on nuclear physics held at the University of Glasgow 12-17 July. Sponsored by the International Union of Pure and Applied Physics and UNESCO, the conference was magnificently organized by the staff of the Glasgow Physics Department headed by P. I. Dee.

During the first 2 days of the conference attention was focused on problems of nuclear forces and nuclear scattering as well as on discussions of nuclear spectroscopy and on the understanding of nuclear data in view of the different nuclear models. After ample time for informal discussions provided by a river cruise on the third day, the conference continued with a somewhat more diversified program for the remaining days. The topics discussed included beta- and gamma-ray transitions, photodisintegration, theory of nuclear-energy levels, field theory, meson theory in general,  $\pi$ -mesons, high-energy experiments, and the production of heavy mesons and hyperons.

Neither spectacular progresses in theory nor excitingly new experimental results were reported in the 105 papers that were presented, but the conference

offered an excellent opportunity for reviewing and summarizing the present position of nuclear and meson theory in view of the recently accumulated experimental data. Considering the wealth of material presented, only a limited number of papers can be discussed here in detail. A comprehensive report of the conference will be found in *Proceedings of the International Conference on Nuclear Physics, Glasgow 1954* (Pergamon Press, London), in press.

Following the welcome address by Dee, the first session, which was devoted entirely to the subject of *nuclear forces and nuclear scattering*, was opened by H. S. W. Massey (University College, London) with a review of the present status of the empirical study of nuclear forces. The information on these forces extracted from *low-energy* (up to 10 Mev) two-body phenomena such as proton-proton (p-p) and neutron-proton (n-p) scattering seems to be consistent with the charge-independence hypothesis of nuclear forces. The experimentally observed difference in the singlet scattering lengths of the p-p scattering and the n-p scattering can be accounted for by electromagnetic effects. Concerning the noncentral aspects of the nuclear forces, characterized by the tensor compo-

ment, and in the low-energy region best evidenced by the nonspherical charge distribution (quadrupole-moment) of the deuteron, the decision concerning the charge independence is far more complicated and no decisive answer can be obtained from the low-energy data available at present.

Studies of the angular distributions in the p-p, p-d, and d-p scattering processes by means of photographic emulsions using a 9.5-Mev proton beam and a 19-Mev deuteron beam were reported by J. Rothlat (St. Bartholomew's Hospital, London). The differential cross sections were found to be about 15 percent lower than those measured by the Los Alamos group at the same energies. The analysis of the variation with angle of the p-p scattering seems to indicate a Yukawa type of potential for the p-p interaction. Absolute differential cross-section measurements for the elastic scattering of 20.6-Mev protons from deuterons were described by D. O. Caldwell (U.C.L.A.). The cross-sections show, in addition to the familiar deep minimum near  $130^\circ$ , a shallower minimum near  $20^\circ$  owing to Coulomb-nuclear interference. In the opinion of the speaker this should allow fitting the data with a unique set of phase shifts and, hence, provide a more stringent test for the theory than previous low- or intermediate-energy nucleon-deuteron scattering experiments.

The crucial problem in *high-energy phenomena*, as pointed out by Massey in his review talk, is again the question of the charge independence of nuclear forces and the character of the exchange forces. Accurate nucleon-nucleon scattering experiments at high energies and their interpretation provide the key to the solution of these problems. Results of measurements of the cross section and the angular distribution of the p-p, n-p, and p-d scattering between 40 and 95 Mev were reported by N. Ramsey (Harvard). The angular distribution of the p-p scattering shows an 8-percent rise between  $90^\circ$  and  $40^\circ$  in the center-of-mass system. The scattering cross section, measured at  $90^\circ$  in the center-of-mass system as a function of energy, varied smoothly between 11.5 millibarn/steradian at 40 Mev and 4.5 millibarn/steradian at 90 Mev and is consistent with the Berkeley and Chicago data. The results on the angular distribution of the neutron-proton scattering are in satisfactory agreement with earlier experiments. Similar measurements on the angular distribution of neutrons scattered by a liquid hydrogen target and detected by a large liquid scintillator were reported by R. Wilson (Oxford).

Massey also showed that the experimental n-p scattering data at high energies can be fitted by using the nuclear force parameters computed from the low-energy data, provided that the odd states do not contribute to the scattering. This is possible if the nuclear forces between the neutron and the proton are assumed to be half ordinary and half exchange forces (Serber force).

As far as the p-p scattering at high energies is concerned, the almost uniform scattering with angle and the slow variation of the cross-section with energy can

be understood on the basis of the low-energy data. However, strong polarization effects of the protons in double-scattering experiments cannot be reconciled by using the same model.

At present there is not even a phenomenological model that adequately describes the simple scattering processes and at the same time satisfactorily explains the strong polarization effects observed on neutron and proton beams.

The polarization of a nucleon beam by a scattering process is due to the noncentral character of the nuclear interaction forces. Experimentally, the degree of polarization of the scattered nucleon beam is observed by the azimuthal anisotropy in a second scattering process. Experiments on high-energy double scattering were described by B. Rose (Harwell), who reported on recent work on high-energy nucleon polarization at Harwell, where a polarized beam of 133-Mev protons having a polarization of 70 percent was obtained by scattering from a carbon target. This beam was then used to study the variation with angle of the polarization in p-p scattering and of the polarization in the elastic scattering of protons from various nuclei. Similar experiments with higher proton energies have been carried out at Berkeley and were discussed by A. C. Helmholtz. There it was also found that a deuteron beam, elastically scattered from carbon, becomes strongly polarized. J. B. Platt (Rochester) reported measurements with a polarized beam of neutrons, obtained from a Be or C target bombarded with a high-energy internal proton beam. Small but significant azimuthal anisotropies were detected for the recoil protons emitted in the second scattering process where the polarized neutron beam struck  $\text{CH}_2$  or C targets. The effects were not markedly dependent on the proton energy.

Information on nuclear forces can also be obtained by considering the interaction between more than two bodies. Massey discussed the binding-energy calculations for  $\text{H}^3$  and  $\text{He}^3$  and in particular the split state of the  $\text{He}^3$  nucleus, which is due to an inverted P doublet. The question arises whether this inversion is the result of a noncentral force of the tensor type or of a force with strong spin-orbit interaction. In order to explain the data satisfactorily by the latter type of interaction, a very large spin-orbit coupling must be assumed.

Also in the first session, a survey of the present status of the meson theory of the two-nucleon interaction was given by R. E. Marshak (Rochester). He pointed out that at present we do not have even the rudiments of a satisfactory theory. For some time the renormalizable charge independent theory for the pseudoscalar  $\pi$ -meson field using pseudoscalar coupling looked rather promising, although difficult calculations (owing to the fact that  $\gamma_5$  is the fundamental operator) are involved. Fourth-order interaction terms have to be taken into account, owing to the large coupling constant ( $G^2/\hbar c \approx 10$ ) and higher order terms seem to be of the same order of magnitude as the second- and fourth-order interaction. (Compare later



paper by H. A. Bethe). Modifications of the theory, proposed by M. Levy in 1952 and further developed by A. Klein, were not very successful in eliminating these difficulties.

The next three sessions of the conference were devoted to *nuclear models and nuclear spectroscopy*. Very appropriately, this discussion was opened by J. A. Wheeler (Princeton) with a survey of nuclear models. The paper was centered around the question of how to reconcile the liquid-drop aspect of the nucleus, as evidenced by the formation of a compound nucleus in nuclear reactions, with the independent-particle aspect of the nucleus, as shown by the successes of the nuclear shell model. Why do the nucleons behave as though they are strongly interacting as in the liquid-drop model and at the same time show independent-particle motion? This question may be answered partially by the recent work of K. A. Brueckner, who derives an effective nuclear potential from the phase shifts for nucleon-nucleon scattering. Owing to the motion of the scattering centers (that is, the nucleons in the nucleus) there occurs a Doppler effect from which a refractive index of the nuclear matter can be calculated without knowing in detail the potential of the nucleon-nucleon interaction. This refractive index describes the effect of the (infinite) nuclear medium on the individual nucleon in a manner similar to the way the optical index of refraction characterizes the behavior of a beam of light in an optical medium. As a result of this approach, it may be shown that only nucleons near the surface show a spin-orbit coupling, a fact that helps in reconciling the strong-interaction and the independent-particle model of the nucleus. Wheeler also discussed the interweaving between the motion of a single particle and the collective modes of the nucleon motion. As particular problems related to this description of the nucleus, the following were mentioned: (i) the influence of deformations on the order of nuclear-energy levels, (ii) the preponderance of positive quadrupole moments, (iii) the selective emission in alpha decay of even-even nuclei, (iv) fluctuations in the dependence of effective surface tension and moment of inertia upon atomic number, and (v) correlation in direction between fission fragments and bombarding particle.

Further evidence of the collective motion of the nucleons in the nucleus was presented by A. Bohr (Copenhagen) who discussed the level structure in even-even nuclei owing to the rotational motion of waves on the nuclear surface. In numerous cases, particularly for heavy nuclei, the energy values calculated for these rotational states are in extremely good agreement with the experimental values. The speaker also discussed briefly the problems involved in the mathematical description of the nucleus on the basis of the unified collective and individual particle model (A. Bohr and B. R. Mottelson).

The rotational states of nuclei are easily excited by the Coulomb field of fast charged particles passing near the nucleus. Reports on these Coulomb excitation processes by alpha particles were presented by G. M.

Temmer and N. P. Heydenburg (Carnegie Institution, Washington, D.C.). Some 130 energy levels in 60 nuclei were investigated, and in the great majority of the cases the level positions were in good agreement with the predictions of rotational states according to Bohr-Mottelson. A number of levels due to single-particle excitation, however, especially in medium heavy nuclei, were also observed with the technique of Coulomb excitation. These levels were distinguished from the rotational states by considerably smaller excitation cross sections.

An approach to the understanding of nuclear structure different from the unified collective-motion individual-particle model is the idea of mixed configuration states, where a particular nuclear state is described by a mixture of different individual-particle wave functions. Results of structure calculations for nuclei of mass 18 and 19 using the mixed configuration idea were presented by B. H. Flowers (Harwell). The calculated numerical results for the energies and radiative widths of low-lying even-parity states and the magnetic moment of  $F^{19}$  seem to agree quite well with experimental studies on the low-lying levels of this nucleus by Coulomb excitation and by the beta-decay of  $O^{19}$ , which were reported by D. H. Wilkinson (Cambridge).

Mixed configurations were considered by two more speakers to explain certain nuclear data. A. M. Lane (Harwell) pointed out that the individual-particle model, when extended to cover mixed configurations, offers a simple explanation of the striking difference between the reduced nucleon widths of resonance levels formed by *s* and *d* nucleon waves, on one hand, and of the levels formed by *p* nucleon waves, on the other hand. Slow-neutron cross-section data were discussed by J. M. Scott (Cambridge) on the basis of a model of the compound nucleus, which somewhat resembles the individual particle model but in which (i) mixed configurations and (ii) a potential well with sloping sides and an exponential tail were considered. Pronounced regularities in the observed magnetic moments emphasizing the importance of the individual particle aspect were discussed by K. M. Guggenheimer (Glasgow).

A general survey of the present status of the experimental knowledge of nuclear-energy levels and of the methods of determining their basic properties, such as the energy, angular momentum and parity, and lifetime, was given by S. Devons (Imperial College, London). The progress concerning the accuracy of nuclear measurements made in recent years and the applicability of new techniques in nuclear measurements—for example, stripping reactions, heavier bombarding particles, polarized particle beams, Coulomb excitation, resonance fluorescence—was emphasized. Of particular interest was Devons' discussion of his method of measuring extremely short lifetimes of nuclear levels. By measuring the difference in the Doppler energy shift of gamma radiation emitted from a nucleus that recoils by virtue of a preceding nuclear process and is stopped in different mediums, the lifetime of the nuclear state



from which the gamma radiation is emitted can be determined. The method works best for lifetimes between  $10^{-13}$  and  $10^{-15}$  sec.

Following this excellent survey there were several experimental papers on nuclear reaction studies. W. W. Buechner (M. I. T.) discussed work on the energy levels of various nuclei with particular reference to results for the isotopes of beryllium, aluminum, and calcium. The levels were investigated by high-resolution magnetic analysis of the products of nuclear reactions. A survey of the type of information obtained from experiments on deuteron stripping was given by J. R. Holt (Liverpool), and some experimental results on (d, n) reactions were discussed. The role of the isotopic spin concept (related to the charge independence of nuclear forces) was clearly emphasized in a paper by K. W. Allen (Liverpool), who reported on a systematic study of the disintegration of light elements bombarded with 1-Mev  $\text{He}^3$ -particles and tritons. High-resolution neutron spectroscopy, as applied to an extensive study of the widths and spacings of resonances in heavy nuclei, was the subject of a talk by D. H. Hughes (Brookhaven). The experimental results for the ratio of the average reduced neutron width to the average level spacing of a single angular momentum state of the compound nucleus indicated a somewhat larger absorption-to-scattering ratio of nuclear matter in heavy nuclei than that assumed in the Feshbach-Weisskopf-Porter (cloudy crystal) model of the nucleus. E. R. Rae (Harwell) reported on studies of gamma-ray yields from the resonant capture of slow neutrons, using the Harwell linear electron accelerator as a pulsed neutron source in time-of-flight measurements.

A nice example of an experiment requiring techniques from very different fields of physics and chemistry is the alignment and polarization of nuclear magnetic moments by high magnetic fields at very low temperature on which S. Bernstein (Oak Ridge) reported. Making use of the hyperfine coupling between nucleus and shell in paramagnetic substances, a nuclear polarization of  $\text{Mn}^{55}$  and  $\text{Sm}^{149}$  nuclei to the extent of about 15 percent was achieved with magnetic fields of several thousand oersteds at temperatures of about  $0.2^\circ\text{K}$ . The samples containing the polarized nuclei were bombarded with a beam of polarized thermal neutrons, and the capture cross-sections of  $\text{Mn}^{55}$  and  $\text{Sm}^{149}$  were studied as a function of relative spin orientations of incident and bombarded particles.

After the numerous, sometimes conflicting, theoretical papers on nuclear models and the equally numerous reports on experimental studies relevant to these models, the excellent summary of the status given by V. F. Weisskopf (M.I.T.) was greatly appreciated. According to Weisskopf, the basic problem of nuclear structure—namely, the question whether the forces between the nucleons in nuclear matter and the forces between free nucleons are the same or not—is not yet decided. The individual-particle approach to the problem of nuclear structure is rather successful near closed shells, whereas between closed shells, where the core is highly

deformable, the collective model of Bohr and Mottelson gives amazingly satisfactory results. Weisskopf was rather doubtful that we really understand the success of this model in predicting the exact energy values of excited nuclear states. Another problem about which the theoreticians are much concerned is the problem of nuclear radii. Experiments involving the charge distribution of the nucleus (electron scattering, mesic-atom experiments) give nuclear radii that follow rather closely the relationship  $R = 1.1 \times 10^{-13} A^{1/2}$ . On the other hand, nuclear radii determined on the basis of nuclear interactions (for example, nuclear cross-section data, radii used in shell model calculations) demand a considerably larger value:  $R = 1.5 \times 10^{-13} A^{1/2}$ . Thus the positive charge of the nuclei seems to be more concentrated toward the center of the nucleus as compared with the average nucleon density. There is also the possibility of reconciling the data by assuming nuclear shapes very different from the usual square well.

The program of session IV consisted of papers on *beta and gamma transitions*. In his review of the main current problems in beta- and gamma-ray spectroscopy, K. Siegbahn (Uppsala) underlined the importance of very high resolution and high accuracy in the measurement of beta- and gamma-ray spectra. As the detection methods become more refined, the complexity of nuclear decay schemes becomes more and more evident, and high resolution is necessary to resolve the details of the spectra. An iron-free spectrometer of a momentum resolution of  $1:10^4$  was discussed. With this instrument one can measure the natural width of conversion lines and determine the width of the levels from which the conversion electrons are ejected. The relative accuracy in electron-momentum measurements has been improved to 1.5 parts in  $10^5$ , an accuracy that allows precise evaluation of atomic constants from beta-spectrometric data.

A paper distinguished by its clarity of presentation was given by C. S. Wu (Columbia) on the interaction in beta decay. The number of possible interaction operators between the nucleons and the leptons (electrons, positrons, neutrinos) can be reduced to five by requiring relativistic invariance. In view of their transformation properties, the coupling terms are called scalar  $S$ , pseudoscalar  $P$ , vector  $V$ , axial-vector  $A$ , and tensor  $T$ . The experiment must decide which interaction or which linear combination of interactions is predominant in beta decay. The assumption of either an  $A$  or  $T$  interaction leads to the Gamow-Teller selection rule for allowed beta transitions ( $\Delta I = \pm 1$  or  $0$ , no  $0 \rightarrow 0$  transitions) of which the  $\text{He}^6$  beta decay is an example, whereas the occurrence of the now well-established  $0 \rightarrow 0$  transitions require a selection rule (Fermi) that can be explained only by assuming an  $S$ - or  $V$  interaction. The momentum distribution of all spectra (except  $\text{RaE}$ ) can be explained by any one of these interactions. The occurrence of both interaction terms  $A$  and  $T$  would give rise to the so-called Fierz interference term, which was not found experimentally. Thus either of the two must be much stronger than the

other. Experiments on the electron-neutrino angular correlation of the  $\text{He}^6$  beta decay (J. S. Allen and W. V. Jentschke, Illinois) showed that the  $T$  interaction is the predominant term. Similar arguments lead to the conclusion that the  $S$  interaction is the important one in the cases obeying the Fermi selection rule. The question now arises concerning the relative contributions of the  $S$  and  $T$  interaction. From a study of the super allowed beta transitions it follows that these two interactions are of about equal strength.

The notorious case of the beta-ray spectrum of  $\text{RaE}$  now seems to allow a satisfactory explanation. First, the angular momentum  $I$  of  $\text{RaE}$  was recently measured by K. Smith (Cambridge) using the atomic-beam method; the result,  $I=1$ , showed that the  $\text{RaE}$  transition is not a  $0 \rightarrow 9$  transition, as was assumed originally. Second, Yamada reinvestigated the effect of the finite nuclear size on the shape of the  $\text{RaE}$  spectrum and found satisfactory agreement with a combination of the  $S$  and the  $T$  interaction. Thus, considering the recent developments, the theory of beta decay seems to be in a quite satisfactory state at present.

Beta decay and the shell model was the subject of a talk by L. W. Nordheim (Duke), who presented statistics for comparative lifetime values in the light of the shell model. For allowed beta transitions and not too low  $A$  values, there is for odd  $A$  a distinction between "one-particle" and "many-particle" transitions, and for even  $A$  between "pairs" and "many-particle" configurations. In first forbidden transitions there is a favored group near the doubly magic 82 protons-126 neutrons configuration and a grouping according to the magnitude of spin change. There is furthermore a fairly marked distinction between nuclei with  $A$  below and above  $\sim 40$ .

M. Goldhaber (Brookhaven) presented a critical comparison of gamma-transition probabilities with the predictions of the extreme individual-particle model (Weisskopf formula). It seems that only magnetic  $2^+$  pole transitions, which have fairly uniform matrix elements throughout the periodic table, agree fairly well with the expectation for a single proton transition. Most other gamma transitions, however, are considerably slower than calculated on the basis of the single-particle model. In some electric gamma transitions the reduced transition probabilities can be explained because neutron jumps are involved or because more than one particle must rearrange in the transition. Gamma lifetimes considerably shorter than what the theory gives for single-proton transitions are found in the fast transitions between low-lying states, in particular for even-even nuclei far removed from closed shells. The increased transition probabilities and the regular dependence of their magnitude on  $A$  indicate again cooperative phenomena involving deformations of the nucleus as a whole. (See the discussion of the collective model of the nucleus.)

A direct measurement of gamma-transition probabilities—for example, by delayed coincidences—is difficult in most cases because of the short lifetimes of the nuclear states involved. Gamma-transition probabili-

ties from a particular excited nuclear level can also be computed from the cross section for the resonance absorption of a photon exciting this nuclear state and subsequently being emitted from this state. Obviously this "resonance fluorescence" process is of observable magnitude only if the energy of the photon to be absorbed is extremely close to the excitation energy of the nuclear level. F. Metzger (Bartol Research Foundation) reported his cross-section measurements of resonance absorption in the scattering of  $\text{Hg}^{198}$ ,  $\text{Hg}^{199}$ , and  $\text{Tl}^{203}$  gamma radiation by the same nuclei. A high linear speed, mechanically attained, compensated for the energy lost to recoil in emission and absorption. Also, Doppler broadening owing to thermal motion was employed to increase the absorption cross section. The magnetic dipole transition probabilities in the  $\text{Hg}^{199}$  and  $\text{Tl}^{203}$  were found to be between 100 and 1000 times slower than those calculated from the single-particle model. Similar resonance-fluorescence measurements on  $\text{Cu}^{63}$  were reported by Ilakovae (Birmingham).

Information on the relative gamma-transition probabilities can be obtained by determining the intensity ratio of the multipole components in mixed gamma transitions. This can be done very accurately by angular correlation methods, owing to the occurrence of interference terms in the correlation function. Measurements of mixed dipole-quadrupole transitions in even-even nuclei by means of angular correlation experiments were reported by R. M. Steffen (Purdue). In all cases investigated the relative intensity of the electric quadrupole radiation, as compared with the competing magnetic dipole radiation, was found to be about 1000 times larger than predicted by the independent-particle model. Several electric dipole transitions with very small admixtures of magnetic quadrupole radiation were also reported, a fact that speaks for a considerable reduction of the electric dipole matrix element in low-energy gamma transitions.

H. Albers-Schonberg (Zurich) discussed the influence of extranuclear fields on angular correlation measurements. It is well known that static and time-dependent electric or magnetic fields may cause a reorientation of the nucleus within the lifetime of the intermediate nuclear state and thus may change the correlation appreciably. The speaker reported on measurements of the gamma-gamma correlation of the  $\text{Cd}^{111}$  cascade using different delays in the coincidence arrangement, thus, on the average, exposing the nucleus for different lengths of time to the interacting fields. The delayed angular correlation displayed by solid sources (mainly static quadrupole interaction) shows the expected dependence on the delay time. Dilute aqueous solutions (mainly time-dependent quadrupole interaction), however, exhibited the same anisotropy with zero delay and with a delay of 4 times the lifetime of the intermediate nuclear state. This result would indicate no attenuating interaction in this type of source, a fact that is incompatible with earlier investigations on viscous liquid sources.

$\pi$ -Mesons and their characteristics were the subject

of session V, which was opened by H. A. Bethe (Cornell) with a general survey of the theoretical problems. Whereas there seems to be little doubt that the  $\pi$ -meson has spin zero and odd parity, the question of the coupling of the  $\pi$ -meson to the nucleon field is still far from a satisfactory answer. In fact, little progress could be reported on this extremely important and difficult problem. In general, two coupling schemes are considered: (i) the pseudoscalar coupling which gives finite results for every process in any approximation, because it is possible in this theory to use renormalization; and (ii) the pseudovector coupling which gives finite results in first-order approximation, but for which the higher order approximations are infinitely large and infinities cannot be removed by a renormalization process.

The coupling between the  $\pi$ -meson and the nucleon field can be explored experimentally by studying the scattering of  $\pi$ -mesons by nucleons or, in a somewhat more complex way, by studying the photoproduction of mesons which involves electromagnetic interactions as well. Still more complex is the production of mesons in nucleon-nucleon collisions.

Experimentally the cross section for the scattering of  $\pi$ -mesons on protons shows a rather sharp maximum near 200 Mev, and the analysis of the angular distribution shows that the scattering is predominantly due to P-waves. The latter could be understood in terms of the pseudoscalar coupling, whereas a further assumption is needed to explain the sharp maximum in the total cross section. In a perturbation theory calculation using only the first term in a power series in  $G^2/\hbar c$ , the pseudoscalar coupling predicts an almost uniform cross section with energy, whereas pseudovector coupling would give a cross section that rapidly and continuously rises with increasing energy. In addition, there is the difficulty that the observed cross sections for  $\pi^+$  scattering are about 3 times larger than the corresponding cross sections for the scattering of  $\pi^-$ , whereas the theory based on the two coupling schemes gives roughly the same cross section for both cases. An assumption that seems to explain these and other data rather satisfactorily has been put forward by Brueckner and Watson and is based on the idea that the meson scattering is governed by the existence of a virtual  $P_{3/2}$  compound state of the meson and the nucleon with total angular momentum  $J=3/2$  and isotopic spin  $T=3/2$ . If it is assumed that the meson-nucleon compound state is about 350 Mev higher than the nucleon ground state, then the scattering cross section should have a broad resonance maximum near this state, as observed. The Brueckner-Watson model also predicts the 3-to-1 ratio of the total cross sections for positive and negative  $\pi$ -meson scattering and explains the observed ratio of the cross sections for charge exchange scattering ( $\pi^+ + p \rightarrow \pi^0 + n$ ) and ordinary scattering of negative mesons. The compound meson-nucleon state also seems to play an essential role in the explanation of the cross-section data for the photoproduction of mesons, for example,  $\gamma + p \rightarrow n + \pi^+$ .

A second maximum at about 1000 Mev was recently observed in the scattering of negative  $\pi$ -mesons on protons. No evidence of such a second maximum was found in the scattering of positive  $\pi$ -mesons. Thus one is tempted to attribute this second maximum in the  $\pi$ -p scattering cross section to a state of isotopic spin  $T=\frac{1}{2}$ . Preliminary calculations based on the Tamm-Dancoff theory, however, give no resonance for this state.

In the next paper R. R. Hildebrand (Chicago) reported on experimental investigations of  $\pi$ -meson production in nucleon-nucleon collisions. He gave further strong evidence for the charge independence hypothesis in  $\pi$ -meson production on the basis of a comparison of the energy and angular dependence of the cross section for the reactions  $p + p \rightarrow \pi^+ + d$  and  $n + p \rightarrow \pi^0 + d$ . Again, the phenomenological model of Brueckner and Watson can explain the experimental results satisfactorily, except that in these reactions the deuterons are formed less often than predicted in the bound state, but rather individual neutrons and protons are observed.

Absolute total cross-section measurements of negative and positive  $\pi$ -mesons in hydrogen were discussed by J. Ashkin (Carnegie Tech.). The measured cross sections for the  $\pi^+$  followed very well the curve representing 3 times the total  $\pi^-$  cross section, indicating that, in the measured energy range, the dominant interaction between  $\pi$ -mesons and nucleons occurs for  $T=3/2$ . Comparison of the experimental  $\pi^-$  cross section with the maximum cross section  $\sigma = (8/3)\pi(\lambda\text{-bar})^2$  calculated for the interaction involving the  $P_{3/2}$ ,  $T=3/2$  state, again supports the idea that this state is especially prominent in the scattering process.

A. M. Thorndike (Brookhaven) described total  $\pi$ -p cross-section measurements at meson energies up to 1500 Mev with cosmotron-produced mesons. For the scattering of positive  $\pi$ -mesons on protons the cross section drops to about 27 millibarns at 450 Mev and is roughly constant at higher energies. The corresponding cross section for negative  $\pi$ -mesons drops to 25 millibarns but then rises to twice this value at 1000 Mev and drops again to 34 millibarns at 1500 Mev. This second broad maximum in the  $\pi$ -scattering curve is the one attributed to a  $T=1/2$  state, as discussed by Bethe. Cloud chamber and emulsion observations show that at the lower energies elastic scattering predominates, but at 1500 Mev many interactions lead to the production of secondary  $\pi$ -mesons. Several cases were observed where two secondary  $\pi$ -mesons were produced. Similarly, two  $\pi$ -mesons are frequently emitted in the production of mesons by nucleon-nucleon collisions at about 2000 Mev. The observations seem to be inconsistent with Fermi's statistical theory. The energy and angular distribution data suggest that the  $P_{3/2}$  compound state may have a large influence on the  $\pi$ -meson production.

A study of interactions induced by 1500 Mev  $\pi$ -mesons in photographic emulsions, reported by Platt, revealed that the most common process at this energy appears to be the inelastic collision with single meson

production. The analysis of the process seems to give further evidence of the  $\pi$ -meson-nucleon compound state.

The charge independence hypothesis in the meson-nucleon interaction predicts a ratio of 2 for the two competing processes  $p + d \rightarrow n + T$  and  $p + d \rightarrow \pi^0 + \text{He}^3$ , while Mayer and Bandtal at Berkeley found the experimental result  $2.3 \pm 0.3$ . Helmholtz reported on this and other recent  $\pi$ -meson work at Berkeley. There, Crawford and Stevenson observed a definite left-right asymmetry in the reaction  $p + p \rightarrow \pi^+ + d$  with a polarized proton beam of 314 Mev.

Session VI was divided into four sections in which papers on *nuclear decay schemes and mesic x-rays*, on *photodisintegration*, on *detailed theories of nuclear models*, and on *field theory* were presented. Particular interest was displayed for the paper on measurements of x-rays due to meson transitions in the atomic orbits. Steinberger (Columbia) in his review of recent meson work at Columbia and Ashkin discussed the capture of  $\mu$ -mesons in atomic orbits and the subsequent emission of x-rays involved in the transition of the  $\mu$ -mesons from one atomic state to another one. Since the mass of the  $\mu$ -meson is 207 times larger than the electron mass, the mesic atomic orbits have a correspondingly reduced Bohr radius, and the energy of the  $\mu$ -meson x-rays is larger. From an accurate measurement of the x-ray energy the mass of the  $\mu$ -meson can be computed. For these calculations electromagnetic corrections are important, especially the vacuum polarization due to virtual pair formation and annihilation in the electric field. Thus measurements of mesic x-rays provide an indirect check of the methods of quantum electrodynamics. Also  $\pi$ -mesons can be captured in atomic orbits and give rise to " $\pi$ -meson" x-rays. The width of the atomic  $\pi$ -meson levels, however, is considerably larger than the width of the  $\mu$ -meson levels owing to the strong interaction of the  $\pi$ -mesons with the nucleons in the nucleus. Quantitative information on the relative probability of radioactive transitions and nuclear capture of the  $\pi$ -meson in the atomic levels is obtained by measuring the fraction of stopped  $\pi$ -mesons which give rise to the mesic x-rays. Such measurements on K x-rays in Be, B, C, N, and O and of L-series x-rays in a range of elements from C to Fe were described by Platt. Similar measurements by DeBenedetti, Stearns, and Stearns and Leipuner were also reported by Ashkin. The Carnegie Institute of Technology group measured rather accurately, by means of the critical absorber technique, the energy of mesic L- and M-lines, for which nuclear effects are negligible at low atomic number Z, and obtained for the mass of the  $\pi$ -meson a value between 272.3 and 273.7 electron masses. The main part of the error is due to uncertainties in the K-edge energies of the critical absorbers used for the energy determination and in the vacuum polarization correction. Owing to the proximity of the mesic K-orbits and the nucleus, specific nuclear interactions may play an important role in determining the energies of the mesic K-levels. There are indications that the energy of the mesic

$2p-1s$  transition of Be is lowered, apparently owing to a specifically nuclear repulsion between the  $\pi$ -mesons and the Be nucleus, whereas that of the  $2p-1s$  transition of B seems to be raised owing to an attraction between the  $\pi$ -meson and the B nucleus.

Among the papers on *detailed meson theory*, on *details of high-energy experiments*, and on *nuclear data* presented in three concurrent groups of session VII, the report of Hildebrand on the observation of nuclear events in the new Glaser bubble chamber particularly attracted the interest of experimentalists. The bubble chamber makes use of the unstable system of a superheated liquid. As soon as ionizing radiation enters the system, gas bubbles are formed and the liquid starts to boil almost immediately. If, however, a picture of the bubble formation is taken a few microseconds after the ionizing event takes place, then the bubbles formed along the path of the ionizing radiation give a beautiful track. The high density of the medium (liquid), the almost complete absence of undesired tracks, and the possibility of taking pictures in rapid sequence make the bubble chamber an extremely versatile instrument for the study of high-energy events.

The last session of the conference was devoted to a discussion of *heavy mesons and hyperons* and was opened with a critical survey of the properties of these new and strange particles by C. C. Butler (Imperial College, London). The speaker was quite successful in his attempt to distinguish between conclusions based on indisputable experimental facts and those based on preliminary evidence. The heavier particles are classified into two groups according to their mass values: the *hyperons*, generally designated by the letter Y, have a mass between the proton and the deuteron mass; and the particles having mass values larger than the  $\pi$ -meson but lower than the proton, are called heavy mesons or *K-particles*. In addition, the "normal" or "light" mesons with masses below (and including) the one of the  $\pi$ -mesons are now classified as *L-mesons*. At present the  $\pi$ - and the  $\mu$ -mesons are the sole representatives of this class. Among the hyperons, the existence of neutral and charged particles with a V-decay is well established. The following characteristics are observed:  $Y^0 = \Lambda^0 \rightarrow p + \pi^- + 37$  Mev (neutral Y-particles are designated by  $\Lambda^1$ ),  $Y^+ \rightarrow p + \pi^0 + 116$  Mev,  $Y^- \rightarrow L^+ + n + 114$  Mev. There is also evidence of a negative  $Y^-$  particle that decays according to  $Y^- \rightarrow \Lambda^0 + \pi^- + 65$  Mev. Among the K-mesons, the existence of the positive and negative  $\tau$ -meson [ $m^+ = (966 \pm 4)m_e$ ] is well established:  $\tau^+ \rightarrow \pi^+ + \pi^+ + \pi^-$  and possibly  $\tau^+ \rightarrow \pi^+ + \pi^0 + \pi^0$ . The positive  $\tau^+$  is observed much more frequently than the  $\tau^-$ . There is some provisional evidence of a neutral  $\tau$ -meson that decays according to  $\tau^0 \rightarrow \pi^+ + \pi^- + \pi^0$ . A neutral particle, which has about the same mass [ $m = (965 \pm 5)m_e$ ] as  $\tau^+$  and which could be the neutral counterpart is frequently observed and is provisionally baptized as a  $\theta^0$  particle. Its decay,  $\theta^0 \rightarrow \pi^+ + L^-$ , has been studied extensively by Thompson (Indiana). The interpretation of some observed events speaks for the existence



of additional K-mesons with masses around  $1200 m_e$ . Leprince-Ringuet (Paris) presented some evidence of a K-meson with a mass of  $m_K = (912 \pm 20) m_e$  whose decay involves a  $\mu$ -meson. This  $K_s$ -meson decays according to  $K_s \rightarrow \mu + \text{neutral particle (neutrino?)}$  and is positive. A negative counterpart may have been observed. The existence of a  $\chi$ -meson ( $\chi \rightarrow \pi + \text{neutral particle}$ ) with a mass between 950 and 980  $m_e$  seems likely. A  $\chi$ -meson that decays into a  $\mu$ -meson and two or more neutral particles seems to be rather well established. Some neutral K-mesons that are not  $\theta^0$  mesons have been observed also.

Most of the observations on the "strange" particles mentioned in the preceding paragraph were made in cosmic-ray experiments. Some of the particles may also be produced by high-energy proton, neutron, and  $\pi$ -meson beams available in the Brookhaven cosmotron. Thorndike reported observations with this machine on the production of K-mesons and on a few V-events. The events are rare, however. A  $\pi$ -meson beam is most effective for producing these "strange" particles.

Two main problems confront the theoreticians in explaining the behavior of the strange particles: (i) Why is there such a variety of particles? (ii) Why is the lifetime of the particles  $10$  and more orders of magnitude larger than expected from their large production probability in high-energy events? Some theoretical speculations concerning especially the latter of

the two questions were discussed by M. Gell-Mann (Chicago) and A. Pais (Princeton). One of two quite different assumptions may explain the puzzling behavior. The first one postulates that the matrix elements for the production and decay are very strongly energy-dependent, for example, because of high angular momentum, which would give copious production at very high energies and a slow decay of the particle, the latter being a low-energy event. The high angular momentum should manifest itself in the angular distribution of the events. The second model starts from the point of view that the strange particles—for example,  $\Lambda^0$ -particles, are produced, two at a time, by  $\pi$ -meson-nucleon or nucleon-nucleon collisions through a strong interaction. The decay of the particle, however, owing to certain selection rules (isotopic spin!) would be forbidden and therefore would proceed slowly.

After this rather controversial topic of the theory of the strange particles, W. Heisenberg (Göttingen) closed the conference with some remarks. In retrospect, he mentioned the way the problems in atomic spectroscopy were solved whose understanding seemed to present unsurmountable difficulties 33 years ago. Perhaps some unexpected development in the future may do for the present somewhat unsatisfactory state of meson physics what the quantum theory did for the understanding of atomic physics.

## News and Notes

### International Union Against Cancer and the 6th International Cancer Congress

The council of the International Union Against Cancer met on 21–22 July in São Paulo, Brazil. The official delegates from the United States were Harold L. Stewart, chairman, Charles S. Cameron, and George T. Pack. A completely revised constitution was adopted which greatly improves and simplifies the operation and organization of the union. For the first time, provision is made for the rotation of the presidency and for the office of president-elect. The headquarters of the union will remain in Paris, but it will be moved from 6, Avenue Marceau, where it has been associated with the French League against Cancer, to the Curie Foundation, 26, Rue d'Ulm, where office space will be furnished gratis. Permanent committees were established to assist in organizing future congresses and to consider problems concerned with the publication of *Acta*, the official journal of the union.

The following officers were reelected for another term: president, J. Maisin (Belgium); secretary-general, Harold Dorn (United States); assistant secretary-general, Pierre Denoix (France); and treasurer, Philip Peacock (Scotland). V. R. Khanolkar (India) was elected president-elect. The five vice-presidents of the union and the areas they represent are as follows:

Antonio Prudente (Brazil), Latin America; O. H. Warwick (Canada), British Empire; Paul E. Steiner (U.S.A.), United States; Tomizo Yoshida (Japan), Asia; and Leiv Kreyberg (Norway), Europe. Plans were made to hold the next cancer congress in London in 1958.

Under the auspices of the union, the 6th International Cancer Congress was held 23–29 July in connection with the 4th centennial of São Paulo. Of the more than 1000 people registered, 400 were from outside Brazil and approximately 135 were from the United States. The program was divided into 6 concurrent sections consisting of 2 lectures, 4 conferences, 10 panel discussions, 15 symposiums on special subjects, 22 films, and 339 scientific papers, making a total of more than 500 individual presentations. Representatives of 48 countries, including the U.S.S.R., participated in the program. Although it is impossible to report in detail on the numerous papers presented, some points of particular interest are mentioned here.

H. Runge (Germany), using primarily radium and x-ray in the treatment of carcinoma of the cervix, reported an absolute recovery rate of 45 percent after 5 yr and 40 percent after 10 yr. In Russia, complete clinical recovery was obtained in the treatment of cancer of the cervix with radiotherapy in 75.1 per-



cent of stage 1 cases, 51.3 percent of stage 2, and 12.5 percent of stage 3, as reported by E. A. Bazlov. After radical mastectomy for the treatment of breast cancer, E. Viacava (Argentina) gave the following figures for those living after 5 yr: 69 percent of stage 1 cases; 29 percent of stage 2, 9 percent of stage 3, and none of stage 4. Stages 3 and 4 patients received radiation and hormone therapy.

In the field of endocrinology, A. C. Griffin (U.S.A.) demonstrated that hypophysectomy of rats completely prevents the liver damage and tumor development that occurs in nearly all intact animals fed the azo dye 3-methyl-4-dimethylaminoazobenzene. The injection of ACTH and growth hormone almost completely restored the carcinogenic effect of the dye. E. Mardones, R. Iglesias, and A. Lipschutz (Chile) produced uterine tumors in guinea pigs by removing one ovary and crushing the other, thereby causing an irregularity in the rhythm of the sexual cycle.

Studies in chemical carcinogenesis by H. P. Rusch, D. Boseh, and R. K. Boutwell (U.S.A.) resulted in the production of skin cancer in mice by painting with croton oil. Heretofore croton oil was considered a cocarcinogen. This work raises questions about the basic concept of cocarcinogens. P. Ermale and L. R. Halsti (Finland) reported that 15 percent of the mice whose oral cavities were painted with tobacco tar developed carcinoma of the urinary bladder. If confirmed, this is important because it shows that the action of the tar is not limited to the area directly exposed. A. J. Vorwald (U.S.A.) described the pioneer work with P. C. Pratt and E. J. Urban in which the inhalation of beryllium sulfate aerosol by rats produced pulmonary cancer with the adenomatous and epidermoid pattern of lung cancer. Investigations by W. F. Dunning and M. R. Curtis (U.S.A.) indicated that excessive dietary tryptophane was the decisive factor in the etiology of cancer of the urinary bladder induced in rats by feeding 2-acetylaminofluorene. The investigations by A. R. Gopal-Ayengar (India) demonstrated that the most pronounced cytochemical effect of total-body radiation on the Ehrlich ascites tumor in mice was the marked accumulation of RNA in the cells.

Carefully controlled genetic experiments, described by W. E. Heslon (U.S.A.), failed to give any evidence that the mammary tumor agent in mice could arise *de novo* as a mutant of some normal cell component, but the experiments suggested that its origin was extrinsic. W. J. Smith (U.S.A.) reported procedures by which the destruction of the sebaceous glands in the skin of mice painted with carcinogens might be used as a test for carcinogenicity. Further development of this method may avoid the necessity of waiting months for cancers to develop in order to determine the carcinogenic potency of some compounds.

Because information about cancer in Russia is so limited, and because of the interest indicated in this matter, the reports of the Russian scientists are described in somewhat greater detail. N. Blokhine outlined the main trends in experimental oncology. Soviet scientists base their work on the teachings of the great

Russian physiologist, Pavlov, emphasizing the unity of the organism; therefore, they cannot admit that tumors are autonomous. They do not support the theory of somatic mutation, although they agree that tumor cells may change under the influence of the environment. The virus theory receives a good deal of support. M. A. Morozov has developed a special coloring substance that enlarges virus particles so that they can be seen in the optical microscope.

Nervous trauma aids the development of tumors and metastases in dogs and mice treated with carcinogens. The inhibition of the activity of the higher nervous centers causes an increase in the number of metastases of the Brown-Pearce tumor in rabbits. Increased nervous activity results in fewer metastases.

I. Chevchenko discussed the use of exfoliative cytology as a diagnostic tool. He indicated that the method was widely used and reported the following accuracy of diagnosis: 87.3 to 98.9 percent for cervical cancer, 83 to 89.6 percent for lung cancer, 92 percent for esophageal cancer, and 69 percent for gastric cancer.

Surgical treatment of gastric cancer was described by A. I. Rakov. Gastric cancer is the most common type in men and women and accounts for 32 percent of all cancers. About 60 percent of the gastric patients are admitted to hospitals. The radical surgery required can be carried out in only about half of these patients. Most surgeons operate for gastric cancer with only a local anesthetic. Usually a subtotal or total gastrectomy is done. Partial resection is considered only palliative. The postoperative mortality for total gastrectomies is 15 to 16 percent. The 5-yr survival rate is about 50 percent in the absence of metastases and 23 percent with metastases. Approximately 10 percent of all gastric cancer patients who report to a physician can be cured.

A. I. Savitski described the Organization of the Fight against Cancer in the Soviet Union. The main organization unit is the Oncological Dispensary which is the center of the anticancer system in major regional localities. It is composed of departments of surgery, obstetrics, otorhinolaryngology, radiodiagnostics, radiotherapy, and roentgenotherapy. It also includes a hospitalization center for patients. There are about 160 of these units in Russia. In addition to diagnosing and treating cancer, they collect and analyze statistics, organize and apply mass prophylactic measures, and supervise public and professional education in cancer. The next unit in the system is the Oncological Station. There are about 870 such stations. Their function is essentially the same as that of the dispensaries except that their jurisdiction is more limited. Finally, the numerous "homes of health education" and Red Cross organization disseminate information about cancer. This state system of health protection is under the supervision of the Committee for the Fight Against Cancer which is attached to the Scientific Council of the Ministry of Health.

The frequency of various types of cancer is as follows: gastric, 32 percent; uterus, 16 percent; skin, 12

percent; breast, 7 percent; mouth and lips, 7 percent; esophagus, 6 percent; rectum, 2.5 percent; and larynx, 1.5 percent. An effort is made to give an annual examination to everyone over 35 yr of age; 10 million people are examined each year. About 0.11 to 0.15 percent of these people have cancer, and 0.8 to 0.9 percent of them have precancerous lesions.

In a press release issued prior to the congress, it was stated that lung cancer has increased in Russia, but this increase is not believed to be related to smoking. Extracts of tobacco painted on lips and skin of mice did not cause cancer. Partial success has been attained in preparing a vaccine to prevent cancer in animals; such a vaccine would be used to treat metastases after the primary tumor was removed. In chemotherapy, analogues of nitrogen mustard, folic acid, and vitamins are used that are less toxic than those available elsewhere. In Russia it is believed that the most important phase of cancer control is early diagnosis.

Some general statements regarding the cancer congress can be made. A particularly good symposium on *Geographical Pathology* considered the variations in incidence and the etiology of various types of cancer in different parts of the world, and a symposium on *Nomenclature of Human Tumors* was especially successful in reaching agreement on an international nomenclature and code to be recommended to WHO. For the first time, the preventive aspects of human cancer received wide attention. There appears to be little doubt that smoking is an important factor in the etiology of lung cancer. The prevailing opinion seems to be that proof is still lacking that, with present methods, early diagnosis has any appreciable effect on prognosis except in special cases.

The many investigators from the United States who participated in symposiums are to be congratulated on having discussed their subjects in a general way rather than emphasizing specific and detailed research results. This enabled the large number of Brazilian physicians to benefit a great deal, and thereby contributed materially to the success of one of the important aspects of the congress. The Brazilians were superb hosts and many people felt that the informal exchange of ideas and the establishment of personal relationships were two of the most important results of the meeting. The representatives from the United States seemed to be in complete concurrence with the president of the congress, Antonio Prudente (Brazil), when he said at the concluding session, "The success of the Congress exceeded our wildest hopes."

U.S.A. NATIONAL COMMITTEE ON THE  
INTERNATIONAL UNION AGAINST CANCER  
National Research Council, Washington, D.C.

## Biologists Invade Florida

The 6th annual meeting of biological societies, sponsored by the American Institute of Biological Sciences, was held 5-9 Sept. at the University of Florida, Gainesville. More than 2000 biologists, members of 25 societies, met to hear some 1000 papers and sym-

posiums, to take part in numerous field trips, and to visit elsewhere in the state. The Gainesville meeting represented the first major national gathering of biological societies to be held in the southeastern area. Representation from the universities and colleges of the region was heavy, but the numbers from the Midwest and Far West were surprising. Many of the papers were regional in nature, and the occasion offered a fine opportunity for all interested in southern and Caribbean research to gather and to compare data.

Sixteen field trips, varying in length from 1/2 day to 4 days, were special features of the meeting. The most ambitious trip was planned by the Ecological Society of America. More than 100 persons spent 4 days traveling and collecting throughout the length of the state, in the Everglades at Cape Sable, down the Keys, and out to a coral reef in the Atlantic Ocean off Miami. The American Society for Horticultural Science arranged a trip that included visits to industries and processing plants, citrus groves, sugar plantations, nurseries, gardens, and horticultural beauty spots. Shorter trips planned by other societies included many of the scenic attractions and also many of the biological attractions, such as Marineland, the Ross Allen Reptile Institute, and the Yerkes Primate Laboratory.

The general meeting featured an address by A. F. Carr, Jr., on "The passing of the fleet." Carr told of the fate of the flotas of Caribbean green turtles, *Chelonia*, from their abundance in the days of Columbus to their present hazardous condition on the brink of extinction. A condensation of Carr's address was published in the October issue of the *AIBS Bulletin*.

At an AIBS symposium, *The Communication of Research Results*, organized by John A. Behnke, contributions were made to the solution of some of the problems that exist in publishing, abstracting, and storing our present accumulation of written scientific knowledge. A report on the papers presented by the five speakers will appear in *Science* and later in the *AIBS Bulletin*.

A special symposium, *Social Organization in Animals*, honoring W. C. Allee, was organized by the Ecological Society of America. Many other societies offered one or more symposiums, and more than 50 speakers took part in these varied programs. Teaching problems in biology, curriculum improvements, and teacher aids and incentives were subjects for several panel discussions.

Of concern to horticulturists was the role and application of combination fertilizers and insecticides. In a cooperative program with the National Joint Committee on Fertilizer Application, K. D. Jacobs (U.S. Department of Agriculture) stated that the consumption of fertilizer-pesticide mixtures in 1952-53 reached a total of 87,000 tons in the United States. Further increased consumption occurred during this last year, particularly in the north-central region, in the control of wireworms and rootworms. Jacobs said that the commercial use of the combinations has al-

ready forged far ahead of research, and further work is needed to determine the best mixtures, the desired rate per acre, the timing of application, the most effective method of application, and the development of new equipment.

R. N. Goodman (University of Missouri) reported that fireblight now appears to be successfully controlled by fewer applications of less concentrated antibiotic sprays than was indicated by experiments a year ago. From 25 to 50 parts of terramycin-streptomycin to 1 million parts of water now seem to be effective.

R. Bruce Ledin (Florida Sub-Tropical Experiment Station) announced the release of a tropical black raspberry that will grow successfully in southern Florida, in fact the first raspberry that will do so. Known as the Mysore berry, it can be propagated by seed, cuttings, or tip layers. So far this new berry has been relatively free of fungus disease and is seldom bothered by insect pests.

During sessions on the social behavior of animals, W. T. James (psychologist, University of Georgia) told of the iron-clad system among dogs in which from puppyhood a dog is destined to be either upper crust, middle class, or an underdog. Born into one of these classes, he must remain there. This hierarchy, based on dominance, appears to be an inherent pattern.

Madge T. Macklin (geneticist, Ohio State University College of Medicine) reported on a recent study of the genetic basis of gastrointestinal cancer in man. Macklin's study showed that stomach and bowel cancer was from 2.5 to 3.5 times as common in the sons and daughters of parents with these cancers as it was in the general population. These children are not destined to develop cancer any more than if they were not related, but if they do, the risk of its being in the gastrointestinal tract is greater.

Scientific evidence, in the form of tape recordings, was offered by W. Frank Blair and David Pettus (University of Texas) to show that frogs and toads employ a special "language" for communication. Recordings demonstrated that differences exist between the calls of closely related species and between individuals. Blair believes that such differences may play an important part in preventing free interbreeding of closely related species. Certainly the calls provide more accurate and easier identification of some species than is possible by examination of physical characteristics.

That female snakes can bear young years after their isolation from males (delayed fertilization) has been known to biologists for some time, but it has not been understood. Wade Fox (Louisiana State University School of Medicine) told ichthyologists and herpetologists that the secret lies in specialized sacs, opening into the oviduct, in which sperm are stored at body temperature. An examination of these receptacles in garter snakes showed the sperm lined up in an orderly fashion with all heads oriented in the same direction. Fox believes that nourishment is supplied in some way, making extreme longevity possible. Since delayed fertilization is known to occur in some turtles as well,

he intends to investigate the possibility that the same mechanism exists there.

The real food of mosquitoes is virtually unknown; blood is not a food but a condiment helpful to the maturing of eggs. A study being conducted on an island in the Gulf by John S. Haeger (Florida State Board of Health) revealed that both sexes of the common salt-marsh mosquito, *Aedes taeniorhynchus*, feed extensively on flower nectaries of Spanish needles, saw palmetto, buttonwood, sea grape, black mangrove, cabbage palm, and the honeydew from green aphids. The daily carbohydrate feeding cycle was found to be related to the male swarming periods, occurring immediately before or afterward. It was found that if a new brood emerged in the vicinity of black mangroves in full bloom, both sexes fed extensively; if, however, no nectar was available at the breeding site, migration was likely to occur.

John T. Curtis (ecologist, University of Wisconsin), reported that soil fungi are even more specific in their choice of habitat than had been believed hitherto. For example, actinomyces are most numerous on dry prairies, and penicillia, particularly those adapted to neutral or slightly alkaline soil, are most abundant in mesic hardwood forests. Curtis is now at work on the soil preferences of each fungus type. This investigation could be of great value in the search for new producers of antibiotics.

A treatment for moniliasis may have been discovered by George H. Scherr (Creighton University School of Medicine). Moniliasis in its early stages is not uncommon as "oral thrush" in infants; later, when it invades deeper organs, it is highly fatal. Using mice, Scherr told how *Pyromen* nearly obliterated all symptoms of the disease. The activity of *Pyromen* appears to be similar to that of cortisone. So striking was the effect of this treatment that a number of investigators in this country and abroad are planning to undertake clinical trials on human beings with advanced stages of the disease.

Laboratory synthesis of lignin was described by S. M. Siegel (California Institute of Technology). Since lignins are the principal waste products of the paper industry, an understanding of their biochemistry is particularly important. Siegel showed that the process begins with a reaction between eugenol and hydrogen peroxide, catalyzed by the enzyme peroxidase.

Daniel I. Arnon and his associates (University of California) reported the first complete photosynthetic reaction in isolated chloroplasts. Measurements showed that the chloroplasts were going through all phases of photosynthesis.

The indefinite storage of living dry seeds seems possible, according to W. E. Loomis, A. M. Bryan, and W. M. Struve (Iowa State College). In experiments with corn, the grain was dried slowly in a vacuum to a weight equivalent to that obtained after 3 days in an air oven at 212°F. When stored in inert gases, the seeds appear to be in a state of "suspended life."

Just as the Gainesville meetings began, a delegate

flew in from Barro Colorado Island, Panama, with a live *Peripatus*. Since most biologists had never seen a live specimen, its presence at the meeting aroused considerable interest. But within hours, "it" became "she" and gave birth to a young *Peripatus*. Twenty-four hours later, the mother again went into labor and this time the event was recorded by camera. However, the attendants at the second blessed event lost their patient within a few hours, presumably to desiccation.

ILEEN E. STEWART

American Institute of Biological Sciences

## Science News

The role of the fish as an experimental animal in biological research is discussed by Ross F. Nigrelli in the *Bulletin for Medical Research* [8, 2 (July-Aug. 1954)]. Nigrelli points out that study of these animals has led to major contributions in experimental embryology, genetics, nutrition, renal physiology, endocrinology, and nerve physiology, as well as in many other fields. Nigrelli lists numerous fishes available for such studies, including tropical freshwater viviparous and oviparous species, temperate freshwater oviparous species, temperate marine oviparous species, and tropical marine oviparous species. All of these can be secured commercially or can easily be collected, and many of them can be maintained in laboratory aquariums that are under proper management.—W. L. S., JR.

The French Academy of Medicine has formally authorized the sterilization of women who, because of bad health, might lose their lives if they became pregnant. The move is expected to raise a medical storm in largely Roman Catholic France. The proposal by Pierre Lantuejoul was adopted by all but one member of the academy.

Three doctors are to examine a patient before the operation is decided upon. One of them, at least, should be accredited by French courts. Lantuejoul discounted objections that could be raised on moral and religious grounds by saying that an abortion killed a human being while sterilization did not.

World Health Organization warning stations are equipped to isolate and identify any new type of influenza virus that may appear quickly enough so that vaccines may be prepared to combat it.

The discovery of two new chemical substances, MECSA and METSA, that preserve the flavor of cooking oils when added in quantities as small as 0.005 percent was announced at the American Chemical Society's 16th Midwest Regional Meeting by A. W. Schwab and C. D. Evans, chemists at the Northern Utilization Research Branch of the U.S. Department of Agriculture, Peoria, Ill. The effectiveness of the preservatives was proved in tests on soybean oil and cottonseed oil.

Each of the compounds preserves flavor by forestalling the action of oxygen from the air, which makes

the oils rancid. Such metals as iron and copper, present in oil in minute amounts, join with oxygen to cause rancidity, but through the process of chelation MECSA and METSA prevent this spoilage. The two compounds appeared to be equally effective in blocking the metals.

Although the new agents satisfy a long-felt need for a readily soluble nontoxic preservative that imparts no undesirable flavor, odor, or color, they tend to decompose when heated. They were tested successfully by adding them to the oil after the heat-treating phase in the processing. The chemical name for MECSA is mono-octadecyl ester of carboxymethylmercaptosuccinic acid. METSA is mono-octadecyl ester of thiosuccinic acid.

The 8 Nov. issue of *Newsweek* contains an account by Wellington Long, chief of *Newsweek's* German bureau, of the Erz Gebirge, the ore mountains south of Leipzig and Dresden, East Germany, that are a main source of Soviet Russia's uranium. The article, which describes a depressing slave-like life among the workers in the area and gives statistical information concerning labor and production, was put together by Long after interviewing a number of refugees from the area. Long wrote:

No Westerner knows for sure how much uranium is produced . . . but a recent report in Bonn indicates . . . enough for 44 atomic bombs. But that really is just a guess. Some West German authorities put the production of pitchblende there at 70,000 tons in 1947, 56,000 in 1950, and 31,000 in 1953. These figures suggest that the Erz Gebirge mines are playing out.

The American Veterinary Medical Association has reported that chickens in New Jersey are succumbing to an unknown liver disease that has resulted in as much as a 40-percent death rate in some flocks. Characterized by red flecks in the liver, the disease has been noted only in chickens 8 wk old or older. Symptoms are lowered egg production, a blue discoloration of the skin, and droopiness. Illness may occur in one pen of pullets without appearing in an adjacent pen where the feeding and management are the same.

One of the new series of synthetic chemical compounds tested for activity against tuberculosis has been found to be effective in animals against strains of tubercle bacilli resistant to the drugs most widely used in tuberculosis treatment. The compound, S-ethyl-L-cysteine, is reported in the November *American Review of Tuberculosis*, journal of the American Trudeau Society, in a paper by Morris Solotorovsky, Seymour Winsten and Elliott Ironson of the Merck Institute for Therapeutic Research, Rahway, N.J., and Horace D. Brown and Harold J. Becker of the Research Laboratories, Chemical Division, Merck and Co.

A white, crystalline, water-soluble substance with a thioethyl component, the new compound does not, however, have the "offensive odor characteristic of



thioethyl compounds" and is well tolerated by experimental animals, according to the investigators who report that it is more active than pyrazinamide or paraaminosalicylic acid (PAS), but less active than isoniazid or streptomycin when given to the animals in their diet.

When injected under the skin, S-ethyl-L-cysteine did not confer a high degree of protection, nor did it show activity against the tubercle bacillus in the test tube. Because of its lack of activity *in vitro*, studies could not be made to determine whether or not tubercle bacilli became readily resistant to the compound.

The Geological Survey, Department of the Interior, has announced that the fossil remains of a **Tritylodontoid** have been excavated on a site near Kayenta, Ariz. This is the first discovery of its kind in the Western Hemisphere. The Tritylodontoids are an ancient group that can be considered either as primitive mammals, or mammal-like reptiles. It is thought that they first appeared late in the Triassic period of the Mesozoic era, about 165 million yr ago, and did not survive beyond the middle Jurassic period of the same era about 145 million yr ago.

Less than 10 small fragments of fossil Tritylodontoids had been found up to 25 yr ago, all in the Old World. Five of these are single teeth or fragments of single teeth; two are small fragments of upper jaws with incomplete teeth; and one is the snout and upper jaw with nine poorly preserved teeth. Since 1930, several less fragmentary specimens have been found. Two incomplete skulls (one with an associated incomplete lower jaw), two upper-jaw fragments, five lower-jaw fragments, two bones, and three fragments of bones were found in the upper Triassic Lufeng series of Yunnan in southwest China. Five upper-jaw fragments and one bone fragment were found in the upper Triassic Stormberg series of South Africa, where the snout end of a skull had been found more than 50 yr before. Finally, jaws, teeth, and bones representing as many as 15 individuals were found in the Rhaetian-Liasic (uppermost Triassic to lowermost Jurassic) of southwestern England. However, to date none had been found in the New World.

The new excavation revealed two rather well-preserved skulls with lower jaws and much of at least one skeleton a short distance below the surface; further quarrying yielded several additional skulls and jaws, together with other skeletal elements. The successful completion of the project is the result of the cooperation among the Bureau of Indian Affairs, the Geological Survey, and the Navajo Tribal Council.

In the November issue of the *American Engineer*, official publication of the National Society of Professional Engineers, G. Keith Funston cites a **Brookings Institution study** which showed that approximately 80,000 engineers, 13 percent, own stock in publicly owned corporations. Funston calls this a surprisingly small total compared with the some 633,000 engineers

in this country employed at the professional level. The Brookings study indicated that 30 percent of the country's engineers receive an annual salary income of \$7500 and above, and 44 percent earn between \$5000 and \$7400.

Duplicating in lambs what had been done earlier in rabbits, G. L. Hunter of the School of Agriculture, University of Cambridge, England, and C. E. Adams and L. E. Rowson of the British Agricultural Research Council have successfully transferred ova from one breed of sheep to another. Lambs fathered by males of the same breed as the real mothers showed the birth-weight characteristics of the true parents and not the "foster" mothers.

The Navy icebreaker *Atka* will sail from Boston 1 Dec. to visit **Little America** and gather information for extensive Antarctic expeditions planned in 1957, the International Geophysical Year. The expedition, in charge of Glen Jacobsen, will spend 2½ mo in Antarctic waters, returning to Boston 14 Apr. 1955. Landing parties will ascertain the presence and condition of supplies left in Little America by earlier explorers, but no land bases will be established. Changes of ice conditions along the shore since the last expedition also will be observed.

Discovery of a long-lived radioactive isotope of aluminum, aluminum-26, by a group of Carnegie Institute of Technology chemists has been announced. Truman P. Kohman, associate professor; James R. Simanton, research associate; and Robert A. Rightmire and Alton L. Long, graduate students, collaborated on the research. The group made the aluminum-26 in the University of Pittsburgh cyclotron with the cooperation of Alexander J. Allen. The new isotope now makes possible the application of isotopic tracing to all known chemical elements. Heretofore aluminum has been the only element without a suitable isotope, for all those previously known have had lifetimes of only a few minutes at most; the new isotope has a half-life of about 1 million yr. The ordinary metal used for construction materials and household utensils is aluminum-27.

The growth and change of **the apple** during the 3000 yr it has been known to man is traced through history and legend in an article by Alan G. May titled, "The king of fruits," appearing in the November issue of *Natural History Magazine*, published by the American Museum of Natural History.

The first successful treatment of acute toxoplasmosis in a human being was announced by R. F. Wettingfeld and R. H. Rowe of the Public Health Service Hospital, Memphis, and Don E. Eyles of the National Institutes of Health, Bethesda, Md., at the recent meeting of the American Society of Tropical Medicine and Hygiene. The patient was a woman laboratory technician who had been working on experimental toxoplasmosis in the Memphis laboratory of NIAH.



After a month of vague illness, she became acutely ill with fever and swollen lymph glands. Her associates at NIH had previously found that a combination of a triple sulfa drug and the antimalaria drug, Daraprim, was highly active against toxoplasmosis in mice, so they gave the same drug treatment to the sick technician. Her response was immediate, and within 48 hr her fever had disappeared and other signs of improvement followed. She had a prolonged period of convalescence but was finally discharged as cured.

**Leo Roy Tehon**, 59, botanist, acting chief of the Illinois Natural History Survey, Urbana, and research professor of plant pathology at the University of Illinois, died on 17 Oct. Dr. Tehon had been with the survey since 1921. For the last several years, he had urged community action in combating phloem necrosis and the Dutch elm disease, and recently had been a leader in urging establishment of a shade tree commission for Champaign-Urbana.

His special interests in the field of research were in mycology, plant diseases, flora of Illinois, penicillin research, artificial immunization of plants to diseases by vaccination, fluorinated compounds as fungicides, and forest and shade tree diseases. He was the author of more than 80 scientific articles.

## Scientists in the News

**Willard F. Libby**, recently named a member of the U.S. Atomic Energy Commission by President Eisenhower, has been appointed a research associate of the Carnegie Institution of Washington, effective 1 Nov. The institution is making facilities available to Libby at its Geophysical Laboratory in Washington, D.C., to enable him to continue his researches on carbon-14 and tritium.

**Roger Williams**, vice president and member of both the board of directors and the executive committee of E. I. du Pont de Nemours and Co., Wilmington, Del., has been chosen to receive the highest award in American industrial chemistry, the Perkin medal of the American section of the Society of Chemical Industry. Williams is being honored for outstanding contributions to many phases of industrial chemical development. Presentation of the award will be made at the meeting at the Waldorf Astoria Hotel in New York on 14 Jan. 1955.

**B. C. P. Jansen**, professor of physiological chemistry at Amsterdam University, well known together with Donath for the isolation and crystallization of thiamin in 1926, reached retiring age this year. On 2 Oct. his students and friends gathered to present him with a portrait of himself, at which occasion he gave his parting lecture. Jansen's activities have been extensive and of great influence on the development of nutritional science in the Netherlands and Indonesia. His career can be divided into three periods: (i) 1909-1916, when he was head of the subdepartment for

physiological chemistry at the Amsterdam Medical School; (ii) 1916-1928, when he was professor of chemistry in Batavia (now Djakarta) in the East Indies; and finally, (iii) his recent years as professor of physiological chemistry on the Amsterdam faculty.

In the first period he was mainly interested in the chemistry of cholic acids, demonstrated through perfusion experiments on the liver and his work on the formation of urea from amino acids. He also organized a teaching system for medical students. During his stay in Indonesia, where there are large-scale nutritional deficiencies, he devoted most of his time to nutrition research, working in the laboratory where Eijkman and Grijns had worked. Both fundamental research, culminating in the isolation of thiamin, and the solution of practical problems were carried out. Included in the latter category were food assays for vitamin A and for the antiscorbutic vitamin, and the determination protein values of local foods. It seems significant to mention that Jansen's and Donath's excellent B<sub>1</sub> assay method with the native ricebird contributed heavily to their success in isolating thiamin.

In Amsterdam from 1929 on, Jansen's aim was to achieve an experimental synthetic diet complete in every respect. His interest stimulated a series of publications from his coworkers on vitamin assay techniques, studies of trace elements, mechanisms of the action of vitamins, and so forth. His laboratory always was full of young people, many of them students who worked on detail projects and received in this way their first scientific training.

His leadership resulted in the development of the Dutch institute for nutrition, which he founded. This organization made funds available for nutrition research independent of the university. In September of this year Jansen, who is a member of the Dutch Royal Academy of Sciences, was president of the 3rd International Congress of Nutrition in Amsterdam.

**Charles A. Scarlott**, former editor of *Westinghouse Engineer*, has joined the public relations department of Stanford Research Institute as manager of technical information services. He has been an author and an editor in the engineering field for more than 20 yr, where engineering has been his specialty.

**Homer J. Stewart**, professor of aeronautics at California Institute of Technology, was honored by his alma mater, the University of Minnesota, at a recent dinner in Minneapolis that commemorated the 25th anniversary of the department of aeronautical engineering. He received the University of Minnesota outstanding achievement award, which is given to former students of the university who have achieved distinction.

**Arthur S. Locke**, expert on guided missiles and fire control equipment, who has been consultant in the radar division of the Naval Research Laboratory in Washington for the past 8 yr, has been appointed associate director of the West Orange (N.J.) laboratory of the Vitro Corp. of America.

**H. Necheles**, director of the department of gastrointestinal research of Michael Reese Hospital, Chicago, and professorial lecturer in physiology at the University of Chicago, has just returned from an extended lecture tour through South and Central America. The gastroenterological societies of Uruguay, Chile, and Peru have nominated him honorary member.

The 12 Oct. issue of the Minneapolis *Star* contained the following editorial entitled "Dr. Densmore."

Dr. Frances Densmore of Red Wing, now 87, is one of the most distinguished living Minnesotans. Her monumental studies on the music of American Indians, incorporated in more than 3000 recordings, 100 articles and 22 books, have won her an international reputation. More than 50 years ago, while old Indians who knew the lore were still alive, Miss Densmore began to collect Indian songs, stories and legends. These are preserved today in the national archives, the Smithsonian Institution, and the records of the Library of Congress.

It is fitting that the Minnesota Historical Society should bestow its first citation for distinguished historical work on Miss Densmore. The award . . . was a worthy tribute to a great career.

**Carl V. Strandkov**, formerly with the Pittsburgh Coke and Chemical Co., has joined the research staff of the Miner Laboratories, Chicago.

After 33 yr of continuous service in the department of physics, University of California, Los Angeles, **Laurence Ellsworth Dodd** retired on 1 July as professor emeritus.

**George W. Irving, Jr.**, has been appointed deputy administrator in charge of research for the Agricultural Research Service in the U.S. Department of Agriculture. In this position he will coordinate the research activities of the 16 branches in ARS engaged in studies covering many fields of agricultural science. Irving, who is a biochemist, has spent most of his professional career in the USDA. His scientific work has been mainly of the fundamental type, including some of the earliest investigations conducted in this country on plant growth regulators and radioisotopes. His research on the biochemistry of plant disease resistance led to the isolation of the antibiotic tomatine.

**Gabriel Lasker**, formerly of Wayne University, is teaching physical anthropology in the department of sociology and anthropology at the University of Wisconsin for the academic year. **Frank Hartung** has also joined that department, where he is taking over the duties of **Marshall Clinard** who is on research leave in Sweden.

Recently the staff of the Neurological Institute, a unit of the Presbyterian Hospital at Columbia-Presbyterian Medical Center, paid tribute to **Edwin Garvin Zabriskie** on the occasion of his 80th birthday. At a gathering in the Columbia University faculty club, he was presented a handtooled leather volume contain-

ing tributes of "esteem and appreciation." Zabriskie retired in 1948 after 2 yr as acting director of Neurological Institute. He is a consultant in neurology to Presbyterian Hospital and professor emeritus of clinical neurology at Columbia University. He is past president of the American Neurological Association and of the Association for Research in Medicine and Neurology, and he is a founder and member of the American Board of Psychiatry and Neurology.

Recently **Brig. Sir John Hunt**, leader of the 1953 British Everest expedition, and **Sir Edmund Herbert**, president of the Alpine Club of Great Britain, were presented with the American Geographical Society's gold Cullum geographical medal and fifteen bronze replicas at an informal ceremony in the American Embassy in London. The award, announced last January, was made in recognition of the expedition's signal achievement in being the first to succeed in climbing Mount Everest. The expedition reached the 29,002-ft summit on 29 May 1953.

Herbert, as chairman of the Joint Himalayan Committee of the Royal Geographical Society and the Alpine Club of Great Britain received the gold medal on behalf of the committee, which sponsored the expedition. Hunt accepted the bronze replicas, one for each of the expedition members, given in recognition of their remarkable teamwork. This award to the entire 1953 British Everest Expedition marks the American Geographical Society's first departure from its precedent of giving the Cullum medal in recognition of individual achievement.

The medal presented to Herbert was one of two identical gold medals struck in making the Everest award. The other was presented to the Thyangboche Monastery in Nepal, in honor of the team of 40 Nepalese Sherpas who participated in the ascent. R. Charles Evans, deputy leader of the expedition, made the presentation at the monastery last April.

## Necrology

**Wallace A. Akers**, 66, former research director of the Imperial Chemical Industries and director of atomic energy research in the Department of Scientific and Industrial Research, London, 1 Nov.; **Sydney G. Biddle**, 65, psychiatrist and past president of the Philadelphia Psychoanalytic Society, Philadelphia, Pa., 28 Oct.; **Vera K. Charles**, 77, botanist and mycologist in the Bureau of Plant Industry, Dept. of Agriculture, Washington, D.C., 2 Nov.; **Leroy D. Edwards**, 57, professor of pharmacology at the Purdue University School of Pharmacy, Lafayette, Ind., 29 Oct.; **Harold A. Knight**, 64, associate editor of *Chemical and Engineering News*, Larchmont, N.Y., 2 Nov.; **John Lennard-Jones**, 60, theoretical chemist and physicist and chairman of the Scientific Advisory Council of the Ministry of Supply, Stafford, England, 1 Nov.; **Daniel S. McAfee**, mining and metallurgical engineer and former vice president of the Dorr Co., New York,

28 Oct.; **William A. P. Moncure**, 72, former professor of mycology at Virginia Polytechnic Institute, Blacksburg, Va., 29 Oct.; **Gordon B. New**, 68, emeritus head of the section on plastic surgery at the Mayo Clinic, Rochester, Minn., 28 Oct.; **O. W. Park**, 65, authority on honey bees and professor of agriculture at Iowa State College, Ames, Iowa, 16 Oct.; **Auguste Rollier**, 80, tuberculosis authority, pioneer of the sun cure, and founder of the International Factory-Clinic, Ley-sin, Switzerland, 30 Oct.; **Samuel S. Sadtler**, 81, chemist, inventor, and a founder of the Electrical Chemical Society, Philadelphia, Pa., 2 Nov.; **Nadia D. Savadskaya**, 76, authority on cancer, author, and director of one of the laboratories of the Curie Foundation, Paris, 1 Nov.; **George B. Wood**, 83, research laryngologist, author, and professor emeritus of laryngology at the University of Pennsylvania's Graduate School of Medicine, Philadelphia, Pa., 2 Nov.

## Meetings

The Council of the European Organization for Nuclear Research recently held its first formal meeting at the Palais Electoral in Geneva and elected Ben Lockspeiser, director of Britain's Department of Scientific and Industrial Research, as president, with Antonia Pennetta, president of the Corte de Cassazione, Rome, and Jacob Nielsen, professor of mathematics at the University of Copenhagen, as vice presidents. Felix Bloch, Swiss-born Nobel prize winner and until recently head of the Institute of Physics at Stanford University, was installed as director general.

The organization came into legal existence on 28 Sept., when the basic convention was ratified by France and the German Federal Republic, followed at once by Norway. Seven other nations had previously completed ratification: Belgium, Denmark, Greece, the Netherlands, the United Kingdom, Sweden, and Switzerland. Ratification by Italy and Yugoslavia is still awaited. The 10 countries that have so far joined are committed to supply 88 percent of the budget.

The center, to be called C.E.R.N., is already at work. More than 100 persons are employed in the Geneva headquarters and about 50 others in Paris, Copenhagen, and Amsterdam. Excavations for a laboratory outside Geneva are under way, and foundations are being built for a large synchrocyclotron. At the meeting of the council, the budget for the first 3 mo of 1955 was approved so that operations can continue while the details of the year's budget are studied.

The program for the European organization includes the construction of a modern laboratory in Geneva for research in high-energy nuclear physics. The laboratory will have two large accelerators—one a 600-Mev synchrocyclotron and the other a 25,000-Mev proton-synchrotron, which will be the most powerful machine of its kind in the world and reach energies ten times greater than the Brookhaven cosmotron

and five times greater than the Berkeley bevatron now under construction. Laboratory and apparatus will cost a hundred million Swiss francs. It will take 7 yr to complete the project.

The organization will be responsible for international collaboration in research on the behavior of very high energy particles of the kind found in cosmic rays, but artificially produced.

The Western Forestry and Conservation Association will hold its 45th annual forestry conference at the Fairmont Hotel, San Francisco, Calif., 8-10 Dec. The theme of the meeting will be *Western Natural Resources and the National Economy*.

The American Association of Spectrographers is planning their 6th annual conference in Chicago, 6 May 1955, on the subject *Industrial Applications of Spectroscopy*. Contributed papers in the fields of emission, x-ray fluorescence, or absorption spectroscopy as applied to industry are invited. *Abstracts must be submitted by 1 Mar. 1955*. Please address all inquiries to: F. E. Stedman or E. E. Stilson, Co-chairmen, Bendix Aviation Corp., 401 North Bendix Dr., South Bend 20, Ind.

An organizational and paper reading session for plant chemists and biochemists was held at Columbia University on 23 Oct. The new group, comprising about 50 persons from the lower New England and Middle Atlantic areas, voted to hold annual meetings and to survey the possibilities for coordinating information and publications in the broad field of plant chemistry. R. F. Dawson of Columbia was elected recording secretary, and D. R. Sprinckon of Columbia and R. A. Barnes of Rutgers were appointed to serve on the program committee for 1955.

During the scientific session papers were read on the chemistry and biosynthesis of natural products by Ulrich Weiss, Marjorie Anchel, Franz Moewus, and R. A. Barnes. Pathways of carbohydrate dissimilation and of nitrate reduction were discussed by Martin Gibbs and Alvin Nason. Chairmen of the sessions were H. B. Vickery of New Haven and R. C. Anderson of Brookhaven National Laboratory.

On 30 Aug. 36 students and nine faculty and staff members from 18 states and 10 foreign countries met in Nashville, Tenn., for Fisk University's 5th annual *Infrared Spectroscopy Institute*. The 45 persons participating in the institute included 5 engineers, 2 biologists, 1 biochemist, 1 mathematician, 10 physicists, and 26 chemists.

During the week-long institute, two lectures were offered each morning, a laboratory session each afternoon, and a lecture each evening. Introductory lectures were given by Ernest A. Jones of Vanderbilt University, James R. Lawson of Tennessee Agricultural and Industrial State College, and Nelson Fuson of Fisk. More specialized lectures were given by Walter E. Brown of the TVA Laboratories, Wilson Dam,

Ala., Wilbur I. Kaye of Tennessee Eastman Co., and Ivar Cooke and Nelson Fuson of Fisk.

The introductory lectures covered the history, techniques, instrumentation, theory, and application of infrared spectroscopy to scientific problems in general. Cooke, in his specialized lecture, discussed the results of his work at the University of Geneva, Switzerland, on an infrared spectroscopic study of intermediate complexes of organo-metallic compounds. Brown reported on work at the TVA laboratory on infrared and Raman spectroscopic studies of phosphoric acids in solution. Kaye gave an authoritative survey of the "near infrared," the vibrational overtone region of the spectrum in which he has played a prominent part in instrumentation during recent months. He also introduced the institute to the use of this spectroscopic region for qualitative and quantitative analysis. Fuson talked on the effect of different solvents upon the infrared spectrums of organic molecules in solution.

Instrumentation as well as applications were stressed in the lectures of Kaye and Brown. This emphasis was particularly appropriate, for in the laboratory sessions of the conference participants were introduced to the use of six different infrared spectrometers, covering the spectrum from the ultraviolet to deep into the infrared. Two of the spectrometers belonged to Fisk University, one to Tennessee A. and I. State College, and three were loaned to the institute by their manufacturers. In addition, three different commercial makes of potassium bromide pellet dies were available to institute students in order that they might have an opportunity to compare results on this newest technique for making solid samples for infrared analysis.

At the opening session the institute coordinator, Nelson Fuson of Fisk, called attention to another infrared spectroscopic meeting being held the same week in Parma, Italy, and as a result a letter of greeting was sent. An answering cable from the International Symposium on Infrared arrived before the close of the Fisk meeting.

## Education

The School of Nursing of the University of Pennsylvania has embarked upon a distinct innovation in nursing education, a 2-yr experimental program in basic nursing leading to a newly approved degree of Associate in Applied Science. This program for high school graduates shortens by 1 yr the time usually required for a nurse to complete her education. Not more than half a dozen other U.S. colleges and universities have instituted similar programs; all of which are designed to shorten the training period for the registered nurse without lowering professional standards.

Oklahoma Agricultural and Mechanical College at Stillwater has completed its Radioisotopes and Radiations Laboratory, which opened formally on 9 Nov.

C. L. Comar, principal scientist, Oak Ridge Institute of Nuclear Studies, was the guest speaker. He discussed the application of radioisotopes to agricultural research. The laboratory is administered by a radiation advisory committee made up of representatives of the several science branches of the college. Roy M. Chatters has been appointed by the committee to serve as coordinator of the laboratory.

Rollin D. Hotchkiss, associate member of the Rockefeller Institute for Medical Research, will deliver Columbia University's annual *Jesup lectures* in the department of zoology on 1, 3, 6, 8, 10, and 13 Dec. He will discuss the *Transfer of Hereditary Properties in Bacteria* in six lectures under the following headings: "Biological fitness in a microbial world"; "Mechanisms of synthesis in bacteria"; "Experimental modification of synthesis in bacteria"; "Chemical and biological nature of the agents of transformation"; "Mechanism of transformation—the receptive cell and the cellular response"; "Natural mechanisms of hereditary transfer."

A Laboratory of Tropical Botany has been initiated by the School of Tropical and Preventive Medicine, Loma Linda, Calif. The purpose of the laboratory is to make field trips into regions of tropical growth to collect specimens for the establishment of a herbarium, for future experimentation on a physiological basis, for study of economic potential, and for specimens containing drugs of possible therapeutic value. The first expedition began in October—a collecting trip to the South American tropics.

## Available Fellowships and Awards

The Division of Medical Sciences, National Academy of Sciences—National Research Council, is accepting applications for grants-in-aid for research in three specialized fields:

(1) The **Committee on Problems of Alcohol** has available a limited fund for the support of grants. The committee is interested in fostering research, primarily on the physiological, biochemical, and pharmacologic effects of alcohol. Applications for the fiscal year 1955–56 should be postmarked *not later than 15 Jan. 1955*.

(2) The **Committee for Research in Problems of Sex** is concerned with encouraging research, primarily on the mechanisms controlling sexual behavior in animals and man. Proposals involving endocrinologic, neurologic, psychological, anthropologic, phylogenetic, and genetic studies directed toward this objective are therefore invited. Requests that deal with the physiology of reproduction or with related biological and biochemical fields will also be considered. Applications for the fiscal year 1955–56 should be postmarked on or before *15 Feb. 1955*.

(3) The **Committee on Drug Addiction and Narcotics** may have available for the coming year limited re-



sources for the support of research in the fields of analgesia and addiction. The committee also invites information on basic research being carried on in these fields, in order that it may extend its activities as a center for the exchange of information on current investigations in this area.

Further details and application blanks may be obtained by writing to the appropriate committee of the Division of Medical Sciences, National Academy of Sciences—National Research Council, 2101 Constitution Ave. NW, Washington 25, D.C.

The **Population Council, Inc.**, has announced an expanded program of fellowships at the predoctoral and postdoctoral levels for advanced training in the study of population. Fellowships will be available for study in universities in the United States and elsewhere for the academic year 1955–56. Preference will be given to qualified applicants from countries other than the United States and Europe.

Fellows will normally receive support for full-time work for a period of 1 yr. The basic stipend of \$2500 per year may be supplemented to provide for travel expenses, maintenance of dependents, and for other exceptional expenses. Somewhat larger stipends may be granted to postdoctoral than to predoctoral fellows. *Application should be received before 1 Mar. 1955.* Requests for further information and for forms should be addressed to The Population Council, Inc., 230 Park Ave., New York 17.

## Grants and Fellowships Awarded

The **National Science Foundation** has announced 216 grants totaling approximately \$2,650,000 for the support of basic research in the natural sciences, for conferences and studies on science, for exchange of scientific information, for scientific manpower, and for travel of American scientists to international scientific meetings. This is the first group of awards to be made for 1955.

University of California. S. Herrick, astronomy. Orbits of Icarus and other astronomical objects, 3 yr, \$5000.

University of California. O. Struve, astronomy. Composition of the stars, 2 yr, \$21,000.

Case Institute of Technology. J. J. Nassau, astronomy. Carbon stars near the Galactic equator, 2 yr, \$13,500.

University of Chicago. A. B. Meinel and W. W. Morgan, astronomy. Microschmidt reddened B-star survey, 18 mo, \$13,000.

University of Chicago. Institute for Nuclear Studies. Chemical reactions in interstellar matter, 1 yr, \$7500.

Indiana University. M. H. Wrubel, astronomy. Evolutionary sequences of stellar models, 1 yr, \$2900.

University of Kansas. H. G. Horak, physics and astronomy. Solar system photometry, 2 yr, \$7500.

Lowell Observatory. E. C. Slipher and A. G. Wilson, Mars committee. Photographic patrol of Mars, 4 mo, \$2000.

University of Virginia. H. L. Alden, astronomy. Astrometric study of selected stars, 2 yr, \$10,000.

University of Wisconsin. A. E. Whitford, astronomy. Absolute spectrophotometry of stars, 2 yr, \$10,000.

University of Arkansas. E. S. Amls, chemistry. Influence of charge and field on chemical processes, 2 yr, \$15,000.

University of California. W. G. Young, chemistry. Displacement reactions involving allylic systems, 2 yr, \$11,500.

University of Southern California. A. W. Adamson, chemistry. Kinetics of ligand exchange with complex ions in nonaqueous mediums, 1 yr, \$5000.

Carnegie Institute of Technology. R. G. Parr and F. O. Ellison, chemistry. Electronic structure of molecules, 2 yr, \$21,500.

University of Chicago. W. F. Libby, nuclear studies. Radio-carbon dating, 2 yr, \$20,200.

University of Chicago. E. A. Long, study of metals. Properties of matter at low temperatures, 2 yr, \$16,000.

Clark University. T. T. Sugihara, chemistry. Yields of long-lived products in the deuterium-induced fission of  $U^{235}$ , 2 yr, \$10,500.

University of Colorado. S. J. Cristol, chemistry. Mechanism of elimination reactions, 3 yr, \$13,000.

Drake University. W. H. Coppock, chemistry. Reaction of aryl esters of chloroformic acid with aromatic hydrocarbons, 1 yr, \$2700.

Duke University. C. Hauser, chemistry. Rearrangements, eliminations, displacements, and condensations, 3 yr, \$20,100.

Florida State University. E. Grunwald, chemistry. Ion solution and ion association in various solvents, 3 yr, \$25,800.

Florida State University. W. Herz, chemistry. Toxic constituents of lantana species, 2 yr, \$13,600.

University of Illinois. J. C. Bailar, Jr., chemistry. Metal complexes in the resolution of optically active organic substances, 2 yr, \$13,000.

Indiana University. W. J. Moore, chemistry. Chemical reactions of ionic beams, 2 yr, \$16,700.

University of Kansas. W. E. McEwen, chemistry. Relative rates of migration of aryl groups in the Schmidt reaction, 2 yr, \$6900.

Lafayette College. J. A. Dixon, chemistry. Preparation and study of *n*-Hexane-d14 and 2,2,4-trimethylpentane-d18, 1 yr, \$5000.

Loyola University. J. L. Huston, chemistry. Isotopic exchange reactions in nonaqueous ionizing solvents, 2 yr, \$8500.

University of Maine. R. Dunlap, chemistry. Liquid-vapor equilibrium for binary solutions of fluorocarbons and hydrocarbons and volume changes on mixing, 2 yr, \$9500.

Massachusetts Institute of Technology. A. C. Cope, chemistry. Transannular reactions of cyclic olefins and related reactions of open-chain olefins, 3 yr, \$19,000.

James Millikin University. C. Weatherbee, chemistry. Manlich type reactions, 1 yr, \$1600.

University of Minnesota. I. M. Kolthoff, chemistry. Convection mercury electrode in the electrolysis of inorganic and organic compounds, 1 yr, \$7000.

University of Nebraska. H. E. Baumgarten, chemistry. Chemistry of simple heterocyclic systems, 2 yr, \$12,400.

University of Nebraska. N. H. Cromwell, chemistry. Stereochemistry and hyperconjugation of three-ring compounds, 2 yr, \$15,000.

University of North Dakota. R. G. Severson, chemistry. Heterocyclic derivatives of silicon, 1 yr, \$3500.

Ohio State University. M. S. Newman, chemistry. Synthesis of highly strained hydrocarbons, 2 yr, \$11,700.

University of Pittsburgh. H. S. Frank and L. S. Mason, chemistry. Relation of structures to properties in liquid solutions, 2 yr, \$20,900.

Princeton University. E. C. Taylor, chemistry. Pyridinopyrimidines, 1 yr, \$3000.

Purdue University. H. C. Brown, chemistry. Effect of molecular shape on chemical behavior, 2 yr, \$17,000.

Rensselaer Polytechnic Institute. G. J. Janz, chemistry. Reactions of cyanogen with unsaturated organic compounds at moderately high temperatures, 2 yr, \$13,800.

San Diego State College. R. W. Isensee and H. Walba, chemistry. Acid-base equilibria in aqueous solutions of aromatic cyclic amidines, 1 yr, \$4200.

Texas Southern University. R. F. Wilson, chemistry. Spectrographic and polarographic study of certain rare earth and transitional elements, 2 yr, \$2800.

Tulane University. J. H. Boyer, chemistry. Preparation and properties of aliphatic diazo compounds, 2 yr, \$6600.

University of Utah. H. Eyring, chemistry. Theory of reaction rates, 2 yr, \$22,800.

University of Utah. W. J. Horton, chemistry. Seven-membered ring compounds, 2 yr, \$12,500.

State College of Washington. G. W. Stacy, chemistry. Additions to Schiff base systems, 2 yr, \$3800.

University of Wisconsin. C. F. Curtiss, chemistry. Theoretical extensions of the kinetic theory of gases, 2 yr, \$14,500.

University of California. C. Stern, zoology. Structure and function of the posterior processes of the brain *Nephtys*, 1 yr, \$6900.

University of Chicago. T. Park, zoology. Effect of irradiation on laboratory populations, 1 yr, \$3800.

Fordham University. C. A. Berger, biology. Changes in chromosome number during development, 1 yr, \$2900.



- University of Illinois. N. D. Levine, veterinary pathology and hygiene. Cultivation of parasitic nematodes, 2 yr, \$9500.
- University of Michigan. N. E. Kemp, zoology. Utilization of yolk in amphibian oogenesis, 2 yr, \$8100.
- Northwestern University. R. L. Watterson, biology. Effect of mitotic inhibitors on feather patterns, 2 yr, \$8000.
- University of Pennsylvania. W. G. Hutchinson, botany. L forms in proteus, 2 yr, \$11,200.
- Yale University. J. P. Trinkaus, zoological laboratory. Cell and tissue transformation, 3 yr, \$12,800.
- University of Arizona. R. H. Braham, Jr., atmospheric physics. Physical properties of clouds, 2 yr, \$50,000.
- University of California. R. E. Holzer, geophysics. Origin of low frequency geomagnetic fluctuation, 1 yr, \$9,400.
- University of California. G. C. Kennedy, geophysics. Silicate systems, 2 yr, \$15,000.
- University of California. F. J. Turner, geology. Fabric of experimentally deformed ionic crystals and rocks, 2 yr, \$13,100.
- University of Chicago. Institute for Nuclear Studies. H. C. Urey. Isotopic abundances relating to geochemical research, 1 yr, \$21,400.
- Earlham College. A. M. Gooding, geology and soil science. Pleistocene terraces of the Upper Whitewater Drainage Basin, 2 yr, \$6000.
- Massachusetts Institute of Technology. W. H. Dennen and E. Mencher, geology and geophysics. Geochemical investigations of sedimentary rocks, 1 yr, \$10,300.
- Massachusetts Institute of Technology. M. J. Buerger, geology and geophysics. Crystal structures of minerals, 2 yr, \$24,000.
- University of North Carolina. S. B. McCaleb, agronomy. North Carolina soils, 2 yr, \$9,400.
- University of Notre Dame. R. C. Gutschick, geology. The Mississippian sedimentary basin in northern Arizona, 2 yr, \$1500.
- Pennsylvania State University. G. W. Brindley, mineral industries. Structural mineralogy of the serpentine group of minerals, 1 yr, \$10,000.
- Pennsylvania State University. R. Roy, earth sciences. Phase rule and polymorphism, 3 yr, \$30,000.
- U. S. Coast and Geodetic Survey. D. S. Cardner, seismology branch. Seismology: Travel-time studies and development of improved travel-time curves for Pacific Ocean region, 2 yr, \$15,000.
- Yale University. C. R. Longwell, geology. Tectonic history of the region around Lake Mead, Nevada-Arizona, 1 yr, \$3500.
- University of California. E. G. Thomsen, mechanical engineering. Mechanics of plastic deformation of metals, 2 yr, \$12,000.
- Cornell University. H. G. Booker, and B. Nichols, electrical engineering. Cause of motion in the Aurora, 2 yr, \$13,300.
- University of Florida. F. E. Richart, Jr., civil engineering. Stress transfer in granular elastic mediums, 2 yr, \$12,600.
- Georgia Institute of Technology. M. R. Carstens, civil engineering. Unsteady flow in smooth pipes, 2 yr, \$13,800.
- University of Houston. A. E. Dukler, chemical engineering. Entrainment in two-phase, gas-liquid flow, 2 yr, \$13,900.
- University of Illinois. C. E. Keeler, theoretical and applied mechanics. Fatigue of concrete, 2 yr, \$20,000.
- State University of Iowa. K. Kammermeyer, chemical engineering. Electric conductivity of thin conductive films on nonmetallic surfaces, 1 yr, \$7500.
- Massachusetts Institute of Technology. R. Ellissen, civil and sanitary engineering. Mechanism of corrosion inhibition by sodium metaphosphate and other chemicals, 2 yr, \$14,000.
- Massachusetts Institute of Technology. T. K. Sherwood, chemical engineering. Mechanism of mass transfer with chemical reaction, 1 yr, \$2900.
- University of Michigan. S. W. Churchill, chemical engineering. Chemical reaction rates for gases passing through shock waves, 2 yr, \$13,200.
- University of Michigan. C. M. Silepcevic, chemical and metallurgical engineering. Light scattering properties of aerosols, 1 yr, \$5100.
- University of North Carolina. H. H. Stadelmaier, engineering research. Disorder-order transformation in  $\text{FeNi}_3$  and the permalloy problem, 1 yr, \$4000.
- Pennsylvania State University. J. N. Brennan, engineering mechanics. Solid state structures in single-crystal metals, 3 yr, \$20,000.
- Purdue University. J. R. Burnett, electrical engineering. Nonlinear servomechanisms, 1 yr, \$10,000.
- Rutgers University. R. K. Bernhard, engineering mechanics. Dynamic soil characteristics: Response curves and critical frequencies, 2 yr, \$16,000.
- Stanford University. C. W. Richards, civil engineering. Effect of specimen size and stress distribution on yielding in mild steel, 1 yr, \$6700.
- University of Texas. M. Van Winkle, chemical engineering. Viscosity and surface tension of homogeneous liquid mixtures at their boiling points, 2 yr, \$10,000.
- University of Utah. S. S. Kistler and E. B. Christiansen, chemical engineering. High temperature glass, 1 yr, \$5100.
- Virginia Polytechnic Institute. M. V. Nevitt, metallurgy. Sigma phase in the ternary systems Cr-Co-Cu and Cr-Mn-Cu, 1 yr, \$8000.
- Washington University. G. Mesmer, applied mechanics. Stresses in pin-loaded eye-shaped bars, 1 yr, \$5900.
- The American Museum of Natural History. C. M. Breder, Jr., fishes and aquatic biology. Interaction of endocrine system, 1 yr, \$6800.
- Indiana University. S. D. Gerking, zoology. Efficiency of food utilization by a fish population, 2 yr, \$10,000.
- University of New Hampshire. E. Swan, zoology. Environmental effects on growth rate and patterns in sea urchins, 2 yr, \$5000.
- University of California. C. Epling, botany. Adaptive mechanisms in selected wild populations of *Drosophila pseudoobscura*, 3 yr, \$20,000.
- University of California. T. Hinton, zoology. Role of genes in the metabolism of nucleic acid and other compounds, 2 yr, \$12,000.
- University of California. A. Lang and S. G. Wildman, botany. Mode of synthesis and inheritance of proteins in plants, 3 yr, \$21,000.
- University of Michigan. D. L. Nanney, zoology. Studies of Protozoan genetics, 3 yr, \$21,000.
- University of Minnesota. J. G. Gall, zoology. Submicroscopic morphology of the animal cell nucleus, 1 yr, \$6000.
- Yale University. H. P. Papasian, plant science. Genetic studies on incompatibility factors in coprinus, 2 yr, \$5500.
- University of Chicago. S. MacLane and S. S. Chern, mathematics. Algebraic topology, 3 yr, \$31,000.
- University of Chicago. A. Weil, mathematics. Abelian varieties and their application, 1 yr, \$6500.
- University of Colorado. S. Chowla, mathematics. Extended Riemann hypothesis, 1 yr, \$9000.
- University of Connecticut. R. D. Schafer, mathematics. Nonassociative algebras, 2 yr, \$10,000.
- Harvard University. R. Brauer, mathematics. Structure of groups of finite order, 1 yr, \$3800.
- Harvard University. O. Zariski, mathematics. Local uniformization on algebraic varieties over modular ground fields, 1 yr, \$5900.
- University of Illinois. C. T. Yang, mathematics. Mappings from spheres to Euclidean spaces, 1 yr, \$6200.
- Institute for Advanced Study, Princeton. L. Ehrenpreis. Theory of distributions, 2 yr, \$11,900.
- University of Kansas. G. B. Price, mathematics. Geometry of function space, 1 yr, \$19,000.
- University of Michigan. C. J. Titus, mathematics. Linear vector spaces of elliptic mappings, 1 yr, \$5000.
- University of Michigan. L. Tornheim, mathematics. Geometry of numbers, 1 yr, \$8000.
- University of New Hampshire. H. G. Rice, mathematics. Recursion theory, 2 yr, \$8700.
- University of Notre Dame. P. Erdos, mathematics. Probability and Related Problems, 1 yr, \$10,000.
- University of Pennsylvania. R. D. Anderson, mathematics. Higher dimensional manifolds, 3 yr, \$23,700.
- Purdue University. L. Gillman, M. Henriksen and M. Jerison, mathematics. Function space algebras, 2 yr, \$21,700.
- Smith College. R. E. Johnson, mathematics. Rings with atomic algebras of ideals, 1 yr, \$3700.
- Syracuse University. A. Edrei, mathematics. Zeros of the derivatives of analytic functions, 1 yr, \$7000.
- University of Virginia. G. T. Whyburn and E. J. McShane, mathematics. Topologic methods in analysis, 3 yr, \$34,400.
- Wayne University. G. Lorintz, mathematics. Summability methods and function spaces, 1 yr, \$8900.
- Yale University. N. Jacobson, mathematics. Jordan algebras, 1 yr, \$8800.
- California Institute of Technology. M. Delbruck, biology. Phototropic responses of sporangiothecae, 2 yr, \$15,000.
- California Institute of Technology. H. Borsook and R. S. Sweet, biology. Metabolism of lysine, 2 yr, \$9000.
- University of California. D. E. Atkinson, chemistry. Autotrophism in hydrogenomonas, 3 yr, \$14,500.
- University of Southern California. P. D. Saltman, biochemistry. Enzymatic mechanism of  $\text{CO}_2$ -fixation in the succulents, 2 yr, \$10,000.
- University of Chicago. B. Vennesland, biochemistry. Enzyme reaction mechanism, 3 yr, \$24,000.

- Duke University. G. W. Schwert, biochemistry. Properties of chymotrypsinogen and of chymotrypsin, 3 yr, \$19,000.
- Florida State University. E. Frieden, chemistry. Properties of ascorbic acid oxidase, 2 yr, \$7400.
- Harvard University. K. Bloch, biochemistry. Enzymatic synthesis of glutathione, 3 yr, \$20,000.
- Harvard University. B. W. Low, physical chemistry. X-ray crystal structure of proteins and peptides, 18 mo, \$10,000.
- Harvard University. F. H. Westheimer, chemistry. Chemical models for enzyme systems, 3 yr, \$24,000.
- Haverford College. A. G. Loewy, biology. Cytoplasmic proteins, 2 yr, \$10,000.
- Iowa State College of Agriculture. S. Aronoff, botany. Bio-synthesis of chlorophyll, 3 yr, \$12,000.
- University of Kentucky. R. L. Hardin and P. R. Moore, biochemistry. Enzymes concerned with phosphorylation of glycerol, 2 yr, \$5500.
- University of Louisville. J. F. Taylor and D. Dallam, biochemistry. Enzymes associated with lipoproteins, 2 yr, \$16,000.
- Loyola University. N. C. Melchior, biochemistry. Molecular structure and the intensity of the absorption of light, 3 yr, \$12,000.
- Northwestern University. J. W. Hastings, biological sciences. Role of flavins in bioluminescence, 2 yr, \$10,000.
- University of Oregon. H. S. Mason, biochemistry. Biochemistry of natural melanins, 3 yr, \$27,000.
- Princeton University. A. M. Chase, biology. Mechanism of enzyme action: Luciferase, 3 yr, \$9500.
- Purdue University. H. Hunt, chemistry. Heats of combustion of amino acids and proteins, 3 yr, \$25,000.
- Rutgers University. W. J. Nickerson and J. R. Merkel, microbiology. Metal-regulated reactions of flavin systems, 2 yr, \$15,000.
- University of Wisconsin. P. P. Cohen, physiological chemistry. Enzymatic peroxidative breakdown of uric acid, 3 yr, \$24,000.
- California Institute of Technology. J. R. Pellam, physics. Cryogenic research, 3 yr, \$34,500.
- Carnegie Institute of Technology. S. A. Friedberg, physics. Investigations in low temperature physics, 2 yr, \$14,700.
- Clemson Agricultural College. J. E. Miller, physics. Study of sulfur, 1 yr, \$5700.
- Columbia University. H. A. Boorse, physics. Research in low temperature physics, 2 yr, \$15,700.
- Columbia University. L. Brillouin, physics. Physics and information theory, 1 yr, \$12,900.
- Columbia University. P. Kusch, physics. Energy levels and hyperfine structure of helium -3 and -4, 2 yr, \$24,300.
- Duke University. H. Sponer, physics. Electronic structure of molecules, 2 yr, \$14,200.
- Georgia Institute of Technology. L. D. Wyly, physics. Angular correlations between nuclear radiations, 2 yr, \$15,000.
- University of Illinois. J. S. Koehler and F. Seitz, physics. Plastic deformation, 2 yr, \$18,100.
- University of Illinois. R. Maurer, physics. Low temperature research on polar crystals, 2 yr, \$14,300.
- Indiana University. K. A. Brueckner, physics. Theory and interpretation of elementary particles, 2 yr, \$32,200.
- Johns Hopkins University. G. H. Dieke, physics. Spectroscopy of rare earths at low temperatures, 1 yr, \$4700.
- University of Kansas. L. W. Seagondollar, physics. Nuclear reactions with 3 Mev protons, 2 yr, \$17,800.
- University of Maine. G. C. Krueger, physics. Phase contrast analysis of nonhomogeneous transient phenomena, 2 yr, \$6600.
- Massachusetts Institute of Technology. B. B. Rossi, physics. Cosmic ray research, 1 yr, \$9300.
- University of Pittsburgh. C. Dean and G. A. Jeffrey, physics. Nuclear quadrupole coupling and x-ray diffraction data, 2 yr, \$11,500.
- Rice Institute. C. F. Squire, physics. Studies in solid state physics, 2 yr, \$22,300.
- University of Utah. J. W. Keuffel, physics. Scintillation counter study of unstable cosmic ray particles, 3 yr, \$24,600.
- University of Vermont and State Agricultural College. A. S. Skapski, physics. Influence of thickness on the melting point of thin lamellae, 2 yr, \$10,300.
- University of Wisconsin. K. M. Watson, physics. High energy nuclear reactions, 2 yr, \$10,300.
- Yale University. C. T. Lane, physics. Low temperature physics, 3 yr, \$26,400.
- Northwestern University. D. J. Lewis and J. W. Cotton, psychology. Research on learning and retention, 2 yr, \$10,200.
- Swarthmore College. W. C. H. Prentice, psychology. Psychological research in the department of psychology, 5 yr, \$27,600.
- Barnard College. Aubrey Gorbman, zoology. Comparative physiology of thyroidal function, 2 yr, \$13,300.
- University of California. E. A. Adelberg, bacteriology. Enzymatic changes in genetic adaptation, 4 yr, \$26,100.
- University of California. C. M. Agress, medicine. Distribution and nature of the sensory coronary arterial innervation, 2 yr, \$12,000.
- University of California. M. Doudoroff, bacteriology. Mechanisms of utilization of carbohydrates by microorganisms, 4 yr, \$26,700.
- University of California. R. B. Livingston, anatomy. Neurophysiological mechanisms in movement and perception, 2 yr, \$20,400.
- University of Southern California. S. C. Rittenberg, bacteriology. Metabolism of malonate by *Pseudomonas fluorescens*, 3 yr, \$24,000.
- Columbia University. E. Chargaff, biochemistry. Role of phospholytic and phosphorylating enzymes in nucleic acid metabolism, 3 yr, \$28,600.
- Columbia University. P. Feigelson, biochemistry. Adaptive enzyme formation in mammals, 6 mo, \$2070.
- Cornell University, Medical College. D. B. Melville. Biochemistry of ergothioneine, 3 yr, \$30,000.
- Hahnemann Medical College and Hospital. A. G. Moat, bacteriology and immunology. Role of biotin in carbohydrate metabolism, 2 yr, \$8200.
- Harvard University School of Dental Medicine. P. L. Munson. Mechanism of stimulation of ACTH secretion, 2 yr, \$15,200.
- Massachusetts Institute of Technology. W. S. McCulloch, electronics. Transmission of signals across the central nervous system, 2 yr, \$25,600.
- New York Medical College. C. Neuberg, biochemistry. Mechanism of action of certain synthetic hydrazine derivatives, 2 yr, \$15,500.
- University of North Carolina. T. Z. Csaky, pharmacology. Relationship between cellular permeability and carbohydrate metabolism, 2 yr, \$10,200.
- North Carolina State College of Agriculture and Engineering. C. McAuliffe, agronomy. Absorption and metabolism of nitrogen compounds by the tobacco plant, 2 yr, \$10,000.
- Texas Agricultural Experiment Station. J. A. Liverman, biochemistry and nutrition. Biochemistry of the photoperiodic response, 2 yr, \$12,000.
- Vanderbilt University. J. H. Park, physiology. Relation of thyroxine to oxidative phosphorylation, 2 yr, \$10,000.
- University of Wisconsin. E. H. Newcomb, botany. Metabolic changes underlying cell enlargement in plants, 3 yr, \$14,100.
- Yale University. G. B. Pinchot, microbiology. Phosphorylation in cell-free bacterial extracts, 2 yr, \$11,600.
- California Academy of Sciences. E. C. Zimmerman. Insects of Hawaii, 2 yr, \$24,600.
- University of Florida. B. B. Leavitt, biology. Analysis of plankton from the deep scattering layer, 1 yr, \$1300.
- Indiana University. J. E. Canright, botany. Floral morphology and anatomy of the Annonaceae, 2 yr, \$5200.
- University of Miami. L. C. Gilman, zoology. Morphologic and physiologic differences among varieties of *Paramecium*, 2 yr, \$7100.
- University of Michigan. Pierre Dansereau, botany. Phytosociological studies in the Canary Islands, 1 yr, \$1700.
- University of Michigan. A. H. Smith, botany. Manual of fleshy basidiomycetes of western U.S., 3 yr, \$12,400.
- Missouri Botanical Garden. R. M. Tryon. Manual of the fern flora of Peru, 3 yr, \$12,100.
- National Academy of Sciences. P. E. Cloud, Jr. Marine mollusks of reefs of the Pacific Ocean, 1 yr, \$1950.
- South Dakota State College. T. B. Thorson, entomology-zoology. Fluid compartments of fishes, 2 yr, \$4000.
- Yale University. J. R. Reeder, plant science. Grass embryo in relation to taxonomy and phylogeny, 2 yr, \$5400.

#### General

- B. W. Jones, mathematics. University of Colorado. To assist in an exchange professorship in mathematics at the University of London, \$1000.
- Naples Zoological Station. R. Dohrn, director. Two American tables at the Naples Zoological Station, 5 yr, \$10,000.
- Smithsonian Institution. Barro Colorado Biological Laboratory, Barro Colorado Island, Gatun Lake, Panama Canal Zone, 2 yr, \$29,000.

#### Attendance at international meetings

- International Congress of Mathematicians. K. Kodaira, mathematics. Princeton University, \$600.
- Tenth General Assembly of the International Union of

Geodesy and Geophysics. P. E. Church, meteorology and climatology, University of Washington, \$700.

Conseil de Physique Solvay. L. Onsager, chemistry, Yale University, \$568.

Fifth Congress on Coastal Engineering. T. Saville, engineering, New York University, \$200.

International Union of Chemistry. H. H. Anderson, chemistry Drexel Institute of Technology, \$650.

Conference on Selection, Training, and Support of Medical Research Workers. E. Allen, research grants, National Institutes of Health; R. Keith Cannon, medical sciences, National Research Council; H. B. Steinbach, zoology, University of Minnesota, \$2675.

#### Conferences in support of science

University of California. Third Berkeley Symposium on Mathematical Statistics and Probability, \$10,000.

National Academy of Sciences. Committee on nuclear sciences, \$18,000.

Robert S. Peabody Foundation for Archaeology. Conference on radiocarbon dating, \$5500.

University of Tennessee. Conference on mechanics of sediment transport, \$5800.

University of Texas. Conference on molecular quantum mechanics, \$5000.

#### International Geophysical Year

National Academy of Sciences. Support of the U.S. National Committee, \$100,000.

#### Exchange of scientific information

American Mathematical Society. Partial support of the transactions of the American Mathematical Society, \$3500.

The American Museum of Natural History. The International Journal, *Insecta Sociata*, \$920.

Bernice P. Bishop Museum. Partial support of secretariat of the Pacific Science Association, \$12,000.

Free University of Brussels. Publication of tables of physicochemical constants of concentrated solutions, \$12,000.

Institute for Advanced Study. Survey of the mathematical foundations of quantum mechanics, \$3300.

International Council of Scientific Unions. Partial support of meeting of the bureau of the International Council of Scientific Unions, \$3700.

#### Studies in science

University of Chicago. Status of demography as a science, \$32,700.

#### Scientific manpower

National Academy of Sciences. Register of scientific and technical personnel in the field of biology, \$17,000.

National Academy of Sciences. Studies on doctoral degrees in science, \$15,000.

## Miscellaneous

MD Publications, Inc., New York, has announced publication of *Antibiotic Medicine*, a new companion journal to *Antibiotics and Chemotherapy*. The first issue of this new journal, which is to be exclusively devoted to clinical studies and practice of antibiotic therapy, will appear in Jan. 1955. Henry Welch is editor-in-chief and Félix Martí-Ibáñez is associate editor. For further information write to the publishers at 30 E. 60 St., New York 22.

Plans have been announced for the construction of an \$800,000 addition to the headquarters of the American Dental Association at 222 E. Superior St., Chicago. The addition will be seven stories high, 25 ft wide, and 125 ft deep and will connect through the west wall of the present structure. Further, a sixth floor will be added to the present five-story building. Construction is expected to be completed in the late fall of 1955. The association now has nearly 82,000 members, an increase of 25,000 in the past 10 yr.

Academic Press, Inc., New York, has published a memorial volume for Richard von Mises entitled *Studies in Mathematics and Mechanics*. The volume was put together under the editorship of Garrett Birkhoff of Harvard University, Gustav Kuerti of Case Institute of Technology, and Gabor Szegő of Stanford University, who say in their preface:

The studies collected in this volume were presented to Professor Richard von Mises as a token of reverence and appreciation on the occasion of his seventieth birthday which occurred on April 19, 1953.

Von Mises' thought has been a stimulus in many seemingly unconnected fields of mathematics, science, and philosophy, to which he has contributed decisive results and new formulations of fundamental concepts. Although it might have been desirable that all sides of his work be reflected in this volume, it appeared wiser to be satisfied with a partial recognition of his interests. Thus the Committee in charge of this publication requested contributions only in the fields of mathematics and mechanics.

Even with this limitation, we found it impossible to invite papers from all those colleagues who at one time or other enjoyed scientific collaboration with von Mises, and only a few of his many former students could be asked to contribute. We hope, nevertheless, that the papers included will give some indication of the ideas associated with von Mises' name the world over. . . .

Von Mises was in full vigor of body and mind when he learned last April about the plan and content of this Anniversary Volume, as it was then called. In May he was taken ill and passed away on July 14, 1953.

We felt that the appropriate decision under the circumstances was to proceed with the publication of the volume as it had been originally presented to him. . . .

Philipp G. Frank's Introduction to this book appeared as an obituary for Dr. von Mises in the 11 June issue of *Science*.

The Naval Research Laboratory in Washington has vacancies for physicists, electronic scientists, and electrical engineers. Salaries range from \$3410 to \$9600. For information write to W. G. Torpey, Code 1817, Naval Research Laboratory, Washington 25, D.C.

Volume 3 of the *Yale Conservation Studies*, published by the Yale Conservation Club, is now available. This volume contains articles of current interest on forestry in Japan, water pollution problems, and the national parks, among others. The papers are written by students and graduates of the Yale Conservation Program. Copies may be obtained for \$1 each from the Yale Conservation Program, 77 Prospect St., New Haven, Conn.

The more than 30 papers presented at the 4th Canadian Textile Seminar, which was held recently at Queen's University, Kingston, Ont., are now available in a bound volume that may be obtained for \$5, post free, from The Textile Technical Federation of Canada, 1410 Guy St., Montreal 25, Que.

## Book Reviews

### *The Optical Properties of Organic Compounds.*

Alexander N. Winchell. Academic Press, New York, ed. 2, 1954. xviii + 487 pp. Illus. \$12.

From the time of Groth's monumental and pioneering five volumes to the excellent monthly publications of McCrone, any assemblage or systematic classification of optical-crystallographic data has been sparse and poorly indexed, because the data themselves have been widely spread (from English, to Dutch, to Japanese) through scientific literature, sometimes buried in an article with a misleading or obscure title, or even left in the laboratory. It is a real pleasure to read and review Winchell's second edition of *The Optical Properties of Organic Compounds*. With the cooperation of various colleagues and the American Cyanamid Company, Winchell has assembled data on, and described, the optical properties of more than 2500 organic compounds. His aim, as stated in the introduction, has been to include all organic compounds whose optical properties are sufficiently well known to permit identification by optical methods, particularly those where refractive indices have been measured.

As far as organic chemistry is concerned, the data is well organized and follows the classic Beilstein arrangement. The book contains two large diagrams, one for the determination of compounds based on birefringence and optic sign and the other for the determination of compounds based on refringence and optic angle. Both have keys. It has a good general index and 631 references. Some crystal diagrams have helpful but fragmental x-ray data with them.

The broad range of organic compounds covered treats only briefly those important to such industries as petroleum (paraffins, p. 4), textiles (aralac and nylon, p. 272), drugs (quinine, p. 290, and barbital, p. 226). I wonder whether this is not just the beginning of a vast assemblage of optical data which will obtain the cooperation of many industries and scientists. More data are needed. In any book of this kind, where collection of data is made from many sources, incompleteness and inaccuracies in data and inability to recheck the optical properties in the laboratory may lead to some misinterpretations. Further, instead of the classical Groth method of reporting refractive indices,  $\epsilon$  and  $\omega$  or  $\alpha$ ,  $\beta$ , and  $\gamma$ , Winchell used  $N_e$  and  $N_o$ , or  $N_x$ ,  $N_y$  and  $N_z$ . At first this seemed amazing, but on second reading it seemed to be much clearer than the Groth method and as American as the "coke" and the "hot dog." One other unavoidable sin of omission is the lack of temperature and dispersion data in relationship to reported refractive indices of many of the organic compounds.

Well bound, on good paper and with clear legible type, this book is easy to read and the crystal diagrams are sharp and well arranged. There are some typographical errors. On the whole, the aim of the

author is achieved, for the book opens a new field and reviews an old field of optical properties of organic compounds for the chemist, the petrographer, the botanist, and that large group of general scientists who are interested in the purity, identity, and structure of organic compounds. We like the book, even with its shortcomings, and use it continuously as a reference book in our classes in chemical microscopy.

MARY L. WILLARD

Chemistry Department, Pennsylvania State University

**Tissue Culture.** The growth and differentiation of normal tissues in artificial media. E. N. Willmer. Methuen, London, and Wiley, New York, ed. 2, 1954. xx + 175 pp. Illus. + plates. \$2.25.

This valuable little monograph gives, in the most concise form possible, the carefully weighed and extracted essence of most of the important developments in tissue culture that took place during the last half century. Willmer is an old hand at the game, and has woven into this little book a very careful evaluation of the work of this period. He quotes more than 400 contributions for which references are given. Never for a moment does the author wander from his subject—the living cell either as a free, living, functioning, and independent unit or as an integral part of a specific functioning and metabolizing tissue. He makes an effort to impress the reader with the need for further exploration in this field, emphasizing the many new techniques and disciplines that can be brought to bear. This fascinating little book should orient anyone on the importance of tissue culture as a major tool of the present and of the future in cellular physiology and pathology.

GEORGE O. GEY

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**A Textbook of Radar.** Staff of the Radiophysics Laboratory, C.S.I.R.O., Australia; E. G. Bowen, Ed. Cambridge Univ. Press, New York, ed. 2, 1954. xiii + 617 pp. Illus. + plates. \$8.50.

This well-known Australian introduction to radar has now been reprinted, with rather minor changes, 7 years after its original publication date. The first 500 pages are identical in the two editions; the last 100 pages have been rewritten to modernize the chapters on the applications of radar systems and microwave techniques.

The book is what its title suggests rather than a description of a series of radar systems. It is well written and well illustrated, and each chapter is by a specialist. The introductory chapter by Bowen is an excellent historical summary of the field by one who played a key part in its development.

A comparison with volume I of the M.I.T. radar



series shows a striking similarity in much of the material covered. This Australian book does not treat moving-target indication in any form, but it has an excellent section on microwave propagation, which is more or less neglected in its American counterpart. This is an excellent book, and one which I thoroughly enjoyed reading.

LUIS W. ALVAREZ

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*Handbuch der Pflanzenkrankheiten*. vol. II, *Die Virus- und Bakterienkrankheiten*, p. 1, *Viruskrankheiten*. E. Köhler and M. Klinkowski. O. Appel and H. Richter, Eds. Paul Parey, Berlin, ed. 6, 1954. 784 pp. Illus. DM. 150.

In 1888 Paul Sorauer prepared a small plant disease book of 250 pages and without illustrations. Later editions were much enlarged, and for the most part they were edited by Otto Appel. The sixth edition, covering diseases and insect pests, is expected to require 15 volumes. The present publication, dealing with virus diseases, has only 132 pages of general information. The remainder of the volume discusses specific diseases on hosts, arranged in orders according to the Engler and Prantl classification. The listing of the viruses is fairly complete, and the discussions are as detailed as the present literature on the individual virus permits. The numerous bibliographies represent world-wide publications in a surprisingly thorough manner. The illustrations, the type, and the paper are excellent. The volume should be a great help, especially to the plant pathologist who is not already deeply versed in the subject.

CHARLES CHUPP

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*Physiology and Biochemistry of the Skin*. Stephen Rothman. Univ. of Chicago Press, Chicago, 1954. xiii + 741 pp. Illus. \$19.50.

By those concerned with the scientific basis of dermatology, this volume will be hailed as a welcome indication of the maturity of the field. To those concerned with skin function as an important, but not the dominating, factor in some other field of physiology, it may well come as a revelation. For it not only makes clear the extensiveness, as well as the intensiveness, of studies during the last 20 years but also convincingly demonstrates the degree to which the resultant knowledge has been integrated and systematized in at least one major school of medical science.

"The main purpose of the book is to serve dermatological research." That the author has succeeded in this task none could dispute. In the doing, however, he has set certain boundaries, which are clearly stated in the foreword, and which should be just as clearly understood by the prospective reader. In the first place, the author has concentrated on those functions which could be considered as unique to the skin, or in which the skin plays an important role. Second, he

has definitely subjugated the interests of such applied fields as clinical dermatology to those of basic research. This latter restriction will undoubtedly cause some disappointment to those with clinical interests. It is most tantalizing, for instance, to be keyed up by an excellent account of sebaceous secretion and its determinants, only to be deserted just when the elucidation of seborrhea seems close at hand. But this is a small price to pay if these self-imposed restrictions were necessary to the production of a basic textbook. If the unresolved tensions should provoke another to produce as scholarly and as informative a book on clinical applications, then humanity will have been doubly served by the present one.

The only serious criticism that I would make concerns the title, which blithely assumes that "skin" is primarily a human possession. More justice would have been done to the rest of the animal kingdom, and potential readers would have been better informed, if the qualification "human" had been included in the title. Nowhere in the book is the function of nonhuman skin discussed unless it directly contributes to the current discussion on human skin. This oversight both illustrates and perpetuates the unfortunate tendency, so frequently encountered, to regard human physiology as "normal" and that of other forms as "special." In cutaneous function, as in so many other respects, it is man who is peculiar, and human peculiarities may be better understood when viewed against the broad background of evolutionary development. For example, due consideration is given to the apocrine sweat glands, and the impression is given that we should not be satisfied with the two pigeon-hole classification that has served us hitherto; but there is no hint of the current controversy over the role of these glands in the heat regulation of mammals, nor is there a suggestion that their role in human physiology may be but a stylized relic of a wider and more flexible evolutionary past.

In organization the book follows a logical sequence, from fundamental biophysical aspects, through sweat secretion and insensible water loss, to histological chemistry, and finally to certain selected special problems such as pigmentation, hair growth, nutritional influences, and the pathophysiology of blister formation. Seven of the 28 chapters are written by contributing authors: Z. Felsner, G. C. Wells, A. L. Lorincz, A. B. Lerner, H. Pinkus, and P. Fleisch. The chapters in the second half are of markedly uneven length, varying from 49 to 4 pages, but this is largely a reflection of the relative state of knowledge on the various topics. The illustrations are numerous, clear, and informative. The photographs are of uniformly good quality. The maintenance of quality in photographs that have appeared in previous publications suggests that care has been taken to secure original prints and to avoid the cumulative foginess of reproduction which so often mars good textbooks. The references are extensive but cogent. In the area of my acquaintance there are few, if any, important omissions.



I will be surprised if any dermatologist interested in the scientific basis of his art will neglect to add this volume to his reference shelves, or if any physiologist involved with skin function will be content merely to borrow it from the departmental library. For the medical historian, it is an excellent example of the fruits to be expected from the marriage of Teutonic thoroughness and New World productivity.

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**Yeast Technology.** John White. Wiley, New York, 1954. xvi + 432 pp. Illus. + plates. \$8.

The meager literature on yeast technology is considerably enriched by this book, which is based on a series of papers published several years ago in *The American Brewer* and the *Journal of the Institute of Brewing*. The author has included "a great deal of further material necessary to produce a reasonably balanced account of the properties and technical employment of the Yeasts."

The work aims at a presentation of some of the important biological factors governing yeast growth and development, together with an account of modern methods used in the industrial propagation of yeasts.

Of particular interest is the mathematical treatment of the problems of yeast growth and fermentation. Such factors as the rate of growth of yeast, deduction of the quantities of yeast present in a fermentation at various times, the amounts of molasses (or other sugar source) and inorganic salts required at various stages, air requirements, and other data depend on simple mathematical laws. Since these are inadequately dealt with in most textbooks they are presented here from first principles.

A convenient index of microorganisms supplements adequate subject and author indexes. The volume will be welcomed by food technologists, chemists, and biologists engaged in all branches of the fermentation, brewing, and baking industries.

CLINTON L. BROOKE

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**Gmelins Handbuch der Anorganischen Chemie: Schwefel (Sulfur),** System No. 9. Edited by Gmelin Institute. Verlag Chemie (U.S. distrib.: Walter J. Johnson, New York, and Stechert-Hafner, New York), Weinheim, West Germany, ed. 8, 1952-53. Section A-2. 450 pp. Illus. Paper, \$35.30. Section A-3. xvi + 252 pp. Illus. Paper, \$34. Section B-1. 372 pp. Illus. Paper, \$29.40.

Prepared with painstaking care and thoroughness, this classic handbook of inorganic chemistry ranks as the most authoritative reference work in its field. Each new portion maintains the same high standards of excellence characteristic of its other portions. Those who know and use Gmelin will welcome the appearance of the up-to-date revisions and appreciate the untiring

effort expended by those who make these revisions possible.

Since the three sections on sulfur considered here, together with section A-1 which is of a historical nature, have already appeared, section B-2, scheduled for the spring of 1955, will complete the treatise on this element.

Section A-2 is of primary interest to the industrial worker. It covers the occurrence of sulfur and its compounds. It also includes some 300 pages on the technology of sulfur, its di- and trioxide, and sulfuric acid; a brief account on patents; a chapter on colloidal sulfur; and a few pages on the physiological effect of sulfur, hydrogen sulfide, sulfur dioxide, and a few sulfur chlorides.

Section A-3 is concerned with the physics and chemistry of elemental sulfur, including the laboratory refining of the element, the preparation of different modifications of sulfur, and the concentration and separation of its isotopes. The sulfur system, as well as the crystallographic, magnetic, and electric properties of the element, are given in detail. Included also are chapters on the electrochemistry of sulfur, the behavior of sulfur with various substances, and the solution of sulfur in nonaqueous mediums.

Section B-1 covers in minute detail the physical and chemical properties of the hydrides and oxides of sulfur and the chemical reactions of these compounds; the portion on sulfur dioxide is particularly extensive.

RALEIGH GILCHRIST

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**For a Science of Social Man.** Convergences in anthropology, psychology, and sociology. John Gillin, Ed. Macmillan, New York, 1954. 289 pp. \$4.

This is an unusual symposium in conception and in execution. It represents neither the proceedings of a symposium nor a collection of papers solicited and organized by an editor. The volume has as its background an interdisciplinary faculty seminar held at the University of North Carolina in 1949-50. John Gillin then called a conference of the contributors to the present book. They agreed upon a plan, returned to their respective universities, and, with some correspondence between them, wrote their chapters. At a second meeting of the group (both conferences were supported by the Wenner-Gren Foundation for Anthropological Research) the chapters were discussed and later revised.

The interdisciplinary net is not spread too widely. It was felt more useful to restrict the inquiry to three fields that are actually in close contact with one another and which many regard as the core of the behavioral sciences. The plan called for a double examination of each paired relationship. Thus Murdock, an anthropologist, reviews sociology and anthropology, while Becker, a sociologist, considers anthropology and sociology. The anthropology-psychology pair is dealt with by Smith and Hallowell, and the psychol-

ogy-sociology pair is handled by Parsons and Newcomb. The editor contributes an introduction and "The forward view."

The chapters are unequal in length and in quality. However, all make useful points and are fundamentally sound. On the whole, the six reviews are more impressive as historical surveys (some of them are very learned indeed) than as builders of new theoretical bridges. There are points of detail with which many professional social scientists would quarrel, but this is a solid and highly useful contribution that should help to clear away needless confusions and misunderstandings. The goal of "the generally accepted rules and definitions of plain English" (p. 7) is not attained in every chapter. The portions written by the editor are clear and forceful.

Gillin takes a rather optimistic view of social science and its potentialities for social action. However, he is no advocate of "cheap and easy integration":

In approaching the possibilities of interdisciplinary collaboration, we propose, if the figure be appropriate, not a Monolithic State, but rather a Federal Union of the specialties dealing scientifically with human behavior in society. In such a Federal Union the several member disciplines would be able to pool their scientific resources for the solution of certain problems requiring multidisciplinary treatment while maintaining a species of "states' rights" that would guarantee full freedom for each member to attend to concerns that seem to be of more specialized interest (p. 4).

In his concluding chapter Gillin considers various theoretical problems, such as models, postulates, and theorems, and the "translation" of underlying biological concepts and propositions about human behavior into social science terms. He considers the following categories common to the three disciplines under review: behavior, grouping, culture, social structure, personality, symbolization, and communication.

CLYDE KLUCKHOHN

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***The Biochemistry of Clinical Medicine.*** William S. Hoffman. Year Book Pub., Chicago, 1954. xx + 681 pp. Illus. \$12.

This volume presents the biochemistry of the body in health and disease for purposes of review and reference by the student and practitioner of medicine. Rather than being organized exclusively on the basis of individual diseases, it deals with the subject through a multiple approach. The biochemistry of the utilization and metabolism of the various nutrients and metabolites and the effects of hormones is considered in some detail. Attention is then paid at appropriate intervals to the biochemistry, physiology, anatomy, and pathology of individual organs, and, finally, individual chapters are devoted to a consideration of the etiology, biochemical pathology, and treatment of various diseases. By this threefold approach, the biochem-

istry of man not only is well-covered but is put in the context of over-all body function or malfunction.

An important portion of the book is concerned with practical information on clinical biochemical procedures, the laboratory findings in health and disease, and their significance. The author writes with a background in chemistry and medicine and with experience as director of biochemistry in a large general hospital.

With its avowed didactic approach, it is well and competently written and avoids shallowness on the one hand and highly technical physical or chemical excursions on the other. The paper, type, and typography are of a high standard.

Despite the publication date of 1954, it would appear that many subjects have not been carried beyond 1952 or even earlier. Coverage is thorough but not exhaustive, as a reader will find who is interested in, for example, hepatolenticular degeneration (Wilson's disease). Much of the chapter dealing with the vitamins is so general, brief, or outdated that it is in contrast with the general high level of most of the book. It is regrettable that this chapter and those concerned with biological antagonists and isotopes could not have been more useful and informative in view of the growing importance of these fields in clinical medicine.

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## New Books

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***The Hidden Life of Flowers.*** Trans. from the French text of J. M. Guiche. Photographs by R. H. Noailles. Philosophical Library, New York, 1954. 93 pp. \$4.75.

***Organic Analysis.*** vol. II. John Mitchell, Jr., I. M. Kolthoff, E. S. Proskauer, and A. Weissberger, Eds. Interscience, New York-London, 1954. 372 pp. \$3.50.

***Modern Aspects of pH.*** With special reference to plants and soils. James Small. Van Nostrand, New York, 1954. 247 pp. \$5.

***Margins of the Sea.*** Maurice Burton. Harper, New York, 1954. 212 pp. \$3.

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***Science Reasoning and Understanding.*** A handbook for college teachers. Intercollege Committee on the Evaluation of Science Objectives of the Cooperative Study of Evaluation in General Education, Paul L. Dressel, director. Brown, Dubuque, Iowa, 1954. 223 pp. Paper, \$3.50.

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- Laboratory Practice of General Chemistry.** George Norman Quam and Edward Lauth Haenisch. Burgess, Minneapolis, ed. 4, 1954. 170 pp. Paper, \$3.
- Mammals of California and Its Coastal Waters.** Lloyd Glenn Ingles. Stanford Univ. Press, Stanford, Calif., rev. ed. of *Mammals of California*, 1954. 396 pp. \$6.
- Lehrbuch der Paläobotanik.** Walther Gothan and Hermann Weyland. Akademie, Berlin, 1954. 535 pp. DM. 46.
- Volume Jubilaire, Victor Van Straelen, Directeur de l'Institut Royal des Sciences Naturelles de Belgique, 1925-1954.** vols. I and II. Institut Royal des Sciences de Belgique, Brussels, 1954. 1213 pp.
- Time Distortion in Hypnosis.** An experimental and clinical investigation. Lynn F. Cooper and Milton H. Erickson. Williams & Wilkins, Baltimore, 1954. 191 pp. \$4.
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# Technical Papers

## Test of the Magnetic Theory of Homing

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Yeagley's magnetic-vertical-Coriolis theory of homing (1, 2) supposes that pigeons are able to home to their lofts because of three essential factors: (i) sensitivity to the effect of flying through the earth's magnetic field, (ii) sensitivity to the forces produced by the earth's rotation acting on masses moving over its surface in a straight line (Coriolis effect), and (iii) visual sensitivity to ground speed. Yeagley asserts that by correlating these three factors, a bird is able to recognize its home locality at the intersection of "a characteristic line in the earth's magnetic vertical field with a characteristic line of latitude" (1, p. 1039).

Yeagley and his collaborators have done a good deal of research in the past several years in an attempt to test the validity of his theory. Their various experiments have been of a large-scale, statistical type; and many have provided suggestive but by no means conclusive results. The experiments of Gordon (3), Matthews (4), and Van Riper (5), on the other hand, appear to contradict Yeagley's results. Moreover, Wilkinson (6) has raised theoretical objections to a magnetic theory, and Thorpe (7) has criticized Yeagley's experimental designs.

The study described here represents a laboratory attempt to test the hypothesis that pigeons are sensitive to the effect of passing through a magnetic field. Specifically the experiment tests the effect of magnetic lines of force moving through stationary pigeons, but from the standpoint of the electromagnetic effect it makes no difference whether a conductor cuts lines of force or *vice versa*.

The conditioning technique was employed throughout the experiment with electric shock used as the unconditioned stimulus. Two female homing pigeons, *Columbia livia* (L), were given preliminary training in buzz-shock and then light-shock sequences. The birds were placed in a Lucite cage 18 in. square. The floor of the cage consisted of an electric grid constructed of parallel  $\frac{1}{8}$ -in. brass rods spaced  $\frac{1}{2}$  in. apart. Grid current could be varied from 0 to 1600 v by means of a variac. Voltages were obtained from a step-up transformer energized by 60 cy/sec alternating current.

The conditioned stimulus for the buzz-shock sequence was a door buzzer placed 2 ft from the cage. For the light-shock sequence the buzzer was replaced by a 200-w bulb suspended 2 ft above the cage. Timing and duration of both conditioned and unconditioned stimuli were by automatic control; the trials were conducted in a sound-insulated room. Training was continued (at 20 trials per day) until both animals were conditioned

to walk or run at the sound of the buzzer and before the onset of shock in 19 out of 20 trials (95 percent).

For the magnetic field-shock sequence, a solenoid 20 in. square and 54 in. long was constructed on a wooden frame. This was achieved by winding the frame with No. 16 Formvar magnet wire, 5 turns to the inch. The axis of the coil was vertical, and the conditioning cage rested in its center. The solenoid thus extended 18 in. above and below the cage, so as to surround it with a uniform field.

Table 1. Number of trials for subjects to reach criterion for learning under three experimental conditions.

Experimental condition	Trials		Criterion reached	
	Bird A	Bird B	Bird A (%)	Bird B (%)
Buzz-shock	820	820	95	95
Light-shock	180	260	95	95
Magnetic-shock	1000	860		

The magnetic field generated by the solenoid rose from 0 to 5 gauss in the same direction 120 times/sec. This varying field was produced by passing 60-cy/sec alternating current through a full-wave rectifier and a 1:1 transformer. The strength of the field was then kept constant during the training by means of a variac and ammeter in the solenoid circuit. Its presence and strength were checked by a gaussmeter. The magnetic field thus produced was substituted for the buzzer and light used previously. Procedure was as before.

The results of the three types of training are presented in Table 1. Figure 1 presents Vincent curves (8) of the learning that took place under the three experimental conditions. These results show clearly that no apparent learning occurred during the mag-

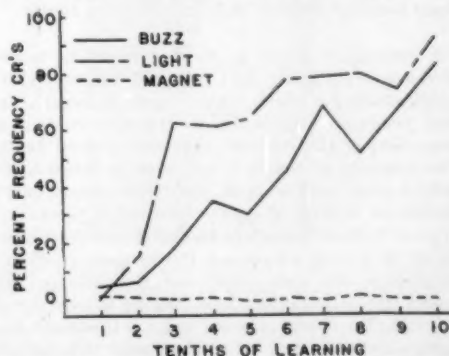


Fig. 1. Vincent curves of the acquisition of conditioned responses in both subjects under three experimental conditions.



netic field-shock sequence, despite the fact that training was continued for a longer period than in the other two sequences. The results gain added significance from the fact that the buzz- and light-shock sequences might be expected to facilitate the learning of a later sequence in which there is only stimulus substitution; that is, positive transfer of training should occur.

However, any conclusions drawn from the obtained results must be qualified in that the experimental design did not duplicate conditions as they are in nature and, consequently, as they are treated in Yeagley's theory. Although the magnetic stimulus used here passed through the intensity of the earth's magnetic field to a value of approximately 25 times the earth's field and did this 120 times/sec, it may have presented these intensities too rapidly, too intermittently, or in some other way that might affect their reception. Nevertheless, the failure to obtain any learning with the magnetic stimulus would seem to cast some doubt on a magnetic theory of homing.

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- \* Present address: Carter Memorial Hospital, Indianapolis, Ind.
- † Present address: U.S. Air Force, Lowry A. F. B., Denver, Colo.
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1 July 1954.

### Relationship of Dental Cavities to General Health

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A concept of bodily health that might be termed *Gestalten* has generally been accepted for many years. Applications for school, employment, insurance, and even personal communications typically contain an assessment of the state of a person's general health. The condition of health is described in broad terms, such as good, fair, or poor, dependent mainly on the number or severity of bodily disorders a person has. Type or types of disorders leading to this designation are not necessarily considered. Furthermore, in all such descriptions the oral cavity and its pathology are almost always neglected. This may be largely due to the fact that dental disease and its treatment is a highly developed specialty which appears to be peripheral to the rest of medicine. A person who has numerous dental cavities filled during a year's time is rarely thought to be in "poor" health. Therefore, the possi-

Table 1. Comparison of DMF score for criterion group and unselected sample.

Group	N	$\bar{X}$	s	t	P
Criterion group	121	31.09	14.76	2.597	.01
Unselected group	1019	27.22	15.55		

bility of a relationship between dental pathology and other bodily dysfunction on this level has never been seriously considered. The following are the results of a study undertaken to ascertain whether such a relationship exists.

The 8-mo cumulative medical histories of a sample of Naval Aviation Cadets were examined. This group comprised a total of 1080 subjects (26 consecutive classes). The name, serial number, complaint, diagnosis, treatment, and disposition of the case were tabulated for each man. It was found that five or more dispensary visits were made by approximately 15 percent of the total population. Assuming frequency of medical complaints as a health index, these 178 subjects could be assumed to represent the "poorest" on a general health evaluation.

The complete dental records, including roentgenographs, of this criterion group were then collected where possible. DMF (decayed, missing, or filled teeth) ratings were made from these records. The DMF rating represents a subject's total past and present dental caries experience. It is compiled by scoring 1 point for each surface of a tooth containing caries or a filling and 3 points for each missing tooth. The resultant mean DMF score of the criterion group was then compared with the mean Naval Aviation Cadet DMF rating formerly established.

Of the 178 subjects in the criterion group, complete dental records were found on 121. The other 57 records were unavailable because the cadets had dropped from the program (1). Table 1 presents the sample statistics for the criterion group and for a large sample representative of the over-all population of Naval Aviation Cadets. As may be seen, the mean DMF established on an independent sample of 1019 unselected Naval Aviation Cadets is 27.22 with a standard deviation of 15.55. The mean DMF of the criterion group is 31.09 with a standard deviation of 14.76. The t-test for the difference between these means yielded a value of 2.60, which is significant at the .01 level of confidence. We should note in passing that this difference was established on a population that can be considered above average in general health, having been screened by a rigorous physical examination prior to admission.

In recent years, dentistry, as well as other branches of medical science, has postulated that certain chronic illnesses affect dental conditions, and conversely (2). The present study therefore provides an interesting relevancy. It presents empirical evidence of a relationship between general health, as measured by frequency of medical complaints, and oral pathology

measured by a decayed, missing, and filled teeth rating. This finding demonstrates that dental caries, as well as other somatic complaints, should be considered in any appraisal that attaches a general term, such as good, fair, or poor, to a person's condition of health.

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- \* LT DC USN.
  - † Tulane University with Nav. Sch. Av. Med.
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- 14 July 1954.

### Chemical Induction of Male Sterility in Cucurbits\*

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Male sterility in crop plants is receiving increased attention for its usefulness in the production of hybrid seed. A chemical method of inducing male sterility would have great merit in certain cucurbits where daily hand removal of staminate flowers on a large scale is economically prohibitive and the maintenance of naturally occurring sterile lines is extremely difficult. This primarily monoecious family presents a special challenge in that flower sex expression has been reportedly altered by chemical treatment (1-3). The chemical suppression of all male flowers in cucurbits would be a means of producing purely female plants.

Preliminary studies were conducted in the greenhouse with cucumbers (*Cucumis sativus*, vars., National Pickling and Burpee Hybrid) and squash (*Cucurbita pepo*, var. Table Queen). By spraying young cucumber plants after 2 to 3 true leaves had formed with 100 ppm of  $\alpha$ -naphthaleneacetic acid (NA) or 25 ppm of 2,3,5-triiodobenzoic acid, the ratios of staminate to pistillate flowers were reduced from approximately 23:1 to 8:1 in National Pickling and from 14:1 to 2:1 in Burpee Hybrid. Results were comparable to those reported by Laibach and Kribben (1), in which the decreases in ratios were accompanied by both an increase in the number of pistillate flowers and a decrease in the number of staminate flowers. NA (100 ppm) applied to Table Queen squash when the first true leaf had fully expanded resulted in an average decrease in staminate-pistillate flower ratio from 1.47:1 to 0.4:1, with occasional plants producing no staminate flowers.

Subsequent field studies (1953) with Table Queen squash revealed that NA (100 ppm) applied as a spray when the seedlings had 1 to 2 true leaves and the treatment repeated 10 days later (4 to 5 true leaves) delayed the appearance of staminate flowers, and treated plants produced exclusively pistillate flowers for 8 days prior to the opening of any staminate flowers.

During the fall, winter, and spring months (1953-54), additional chemicals, including maleic hydrazide (4), were evaluated. Table Queen squash (Stock No. D0421, Ferry-Morse Seed Co.) was used as the test plant (2) and was grown in the greenhouse at 68°F night temperature and a photoperiod of 16 hr. Such an environment normally favored the early production of staminate flowers followed by the presence of both staminate and pistillate types, as described by Nitsch *et al.* (2).

A remarkable suppression of staminate flower buds was obtained with maleic hydrazide (MH); the selective inhibition was comparable to that reported by Moore (5) and Naylor (6) for maize. Several spray patterns successfully induced male sterility during the 3- to 4-wk interval that each crop was allowed to flower in the greenhouse. Dipping or spraying the plants in a solution containing 250 or 350 ppm of MH when the first true leaf was expanding and followed by a second treatment when 4 to 5 true leaves had developed resulted in plants that produced the usual number (8 to 10) of pistillate flowers in normal spatial arrangement, with no staminate flowers. Characteristic flowering patterns following treatment showed only rudimentary staminate flower buds or bud initials at the nodes in which they normally occurred. In other instances nonfunctional staminate male flower buds developed in which the sepals were abnormally enlarged (Fig. 1B) and some flowers eventually opened, but the androecia failed to develop (Fig. 1D), having aborted in a manner similar to that of the male-sterile mutant in winter squash described by Scott and Riner (7). It was further found that a single application of MH (250, 350, or 500 ppm), applied when 1 to 2 true leaves had developed, resulted in a high percentage of plants that produced only pistillate flowers.

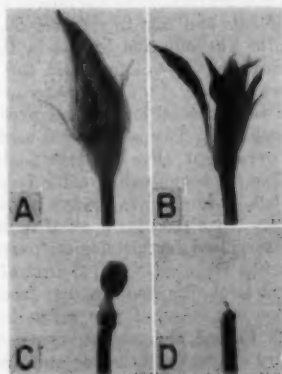


Fig. 1. Effect of maleic hydrazide (MH) on staminate flower bud development in squash (var. Table Queen). (A) and (C) Normal buds intact and with the sepals and petals removed to show the fully developed androecia. (B) and (D) Buds from plants previously treated with MH (350 ppm), intact and with the sepals and petals removed. Such buds were typical of treated plants, aborting prior to anthesis and containing no viable pollen.

Repeated (4 to 5) applications at 5- to 7-day intervals of 100 ppm, beginning at the time of cotyledon expansion and continuing until 4 to 5 true leaves had developed, effectively suppressed staminate flower bud development in many plants. The pistillate flowers on male hydrazide-induced male-sterile plants in almost all instances appeared normal and were fertile. When pollinated the fruit developed normally and produced abundant quantities of viable seed. Investigations now in progress suggest that the results reported here for Table Queen squash can be reproduced in many varieties of *C. pepo* and in other cucurbitaceous species and may have widespread utility in making the production of hybrid seed an economic reality.

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- 9 July 1954.

## Recovery from the Failure to Eat Produced by Hypothalamic Lesions

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In two recent papers, Anand and Brobeck (1) have reported that bilateral lesions of the lateral hypothalamus can cause rats and cats to refuse food and thus starve to death. The effective lesions in these cases were 1 mm above the floor of the brain and 2 mm off the midline on each side, at the same anterior-posterior setting as the ventromedial lesions that produce overeating (hyperphagia). Two of the cats used in these experiments were kept alive by tube-feeding postoperatively. One cat began eating after 7 days of refusing food, but its intake was always below normal. The second cat refused food for 6 wk of tubing and at this time was sacrificed for histological purposes.

The experiment reported here (2) first of all verifies Anand and Brobeck's findings that lateral hypothalamic lesions can cause rats to refuse to eat and starve to death. Second, the present experiment shows that a recovery of eating behavior can be brought about in such animals.

Bilateral lesions in the lateral hypothalamus were made with the aid of a stereotaxic instrument (3) so as to produce animals that refused laboratory food (Purina Laboratory Chow Meal) and water for at least 5 days postoperatively. These starving animals were then divided into two groups, one of which was maintained with only laboratory food and water and

was thus allowed to starve to death, while the second group was maintained with a nutritive, fluid diet (4) administered by stomach-tube. Within a few days after tubing was begun, these animals were offered a number of special foods in an effort to induce them to eat.

All 40 operated rats showed some failure to eat following the lateral hypothalamic lesions: 9 rats, used in preliminary work, refused to eat for a period of 6 to 9 days postoperatively but then recovered eating behavior spontaneously; 17 rats that were not tubed or offered special food refused to eat laboratory food and to drink for 6 to 15 days and thus starved themselves to death in this postoperative testing period; 14 rats, maintained with tubing and special foods, recovered eating and drinking behavior within 6 to 65 days.

The course of recovery of the eating behavior is illustrated in Fig. 1 by data on one animal. All 14 recovered animals showed the same general course of recovery of eating behavior following lateral hypothalamic lesions. There is an initial period of complete refusal to eat. Following this, animals will accept only evaporated milk or, somewhat less readily, milk chocolate. Only later will they accept water; and only after they have been drinking water will they eat the regular laboratory food. Individual differences in the time spent in each of these stages of recovery are very great, but the sequence of stages is almost invariable.

Tubing the animals may retard the recovery of eating somewhat; yet in a number of cases where tubing was stopped as soon as the animals began to eat the special foods, the final course of recovery was also prolonged. Starvation itself is never a sufficient inducement to eat, for even after animals had been eating evaporated milk and chocolate, they still refused to eat laboratory food when deprived of these special foods, even to the point of great weight loss.

Foods other than evaporated milk or chocolate, of

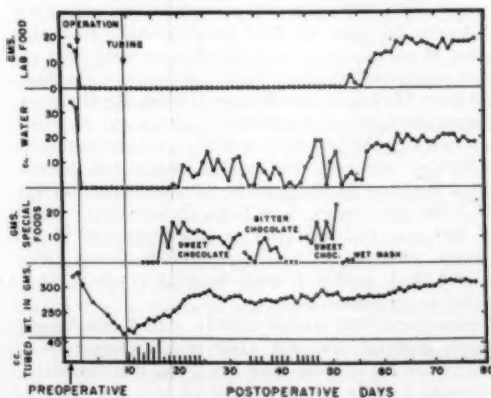


Fig. 1. Course of recovery of eating behavior in one rat, following complete refusal to eat produced by hypothalamic lesions. The x's show when 25 g of evaporated milk was offered and eaten.

course, might elicit eating in the early postoperative periods, but thus far we have had very little success with a number of foods tried: Purina Laboratory Pellets, a mash of 50 percent powdered laboratory food and water by volume, the same mash sweetened with dextrose, straight dextrose, and fresh ground beef. Yet some of our animals would eat bitter baker's chocolate, although in smaller quantities than milk chocolate.

Once rats recover the ability to eat postoperatively, they maintain the same intake of laboratory food and water as comparable normal animals and can regain and hold their preoperative weights. Nevertheless, it seemed worth while to determine more adequately whether or not recovery was complete. Some preliminary comparisons between six normal rats and six recovered rats were made. (i) When fed laboratory powder diluted with nonnutritive cellulose (25 percent by weight), both normal and recovered rats increase their gram intake by about 25 percent, thus maintaining their caloric intake. The recovered animals, however, reduce their intake for the first 3 to 4 days of cellulose-dilution, whereas normal animals make the adjustment within the first day. (ii) Both normal and recovered animals strongly prefer chocolate and evaporated milk when these are offered in addition to laboratory powder and water and reduce their intake of laboratory powder and water by 50 and 75 percent, respectively. (iii) The recovered animals prefer pure corn oil much more than do normals when it is offered in addition to laboratory powder and water. Controls take less and less oil on successive days and the recovered animals take more and more, until, by the end of 3 days, the controls are consuming less than one-half as much oil as the recovered animals.

These findings suggest a number of interpretations. (i) It seems that the lateral hypothalamic lesions impair an excitatory mechanism important in eating. Supporting this idea is the finding of Delgado and Anand (5) that stimulating this region through implanted electrodes can greatly increase eating behavior. (ii) The loss of eating behavior is only temporary. This fact itself is not surprising, for the same recovery of function has also shown up following changes in sleep (6), temperature regulation (6), and emotion (7) induced by lesions of the hypothalamus and related subcortex. The real questions are: What is the nature of the recovery (and therefore the loss)? What is the neural mechanism involved in the recovery? (iii) Some insight into the nature of the loss of function has been gained by plotting the course of its recovery. From our findings with evaporated milk, chocolate, and corn oil, we propose the hypothesis that fat may elicit eating behavior in operated animals sooner and more readily than other foods. Rephrased in more general terms, lesions of the lateral hypothalamus may change the rat's reactions to certain stimulus-aspects of the diet. At first rats will respond to no food stimulus postoperatively. After some recovery, certain food stimuli (provided by fats?) will elicit eating but others still will not. Finally, the recovered rats seem

responsive to enough of the stimuli provided by laboratory food to eat it as normals do, but they still seem to have a heightened fat-appetite.

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- \* Present address: Department of Psychology, Harvard University.
- † Present address: Institute of Neurological Sciences, University of Pennsylvania Medical School.
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8 July 1954.

## Amperometric Determination of Disulfides in Intact Proteins

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In studies on disulfide bonds of proteins involved in blood coagulation (1, 2), it was found that the amperometric technique for —SH determinations (3) could be adapted, with modifications, to the measurement of —S—S— also. The basic principle, outlined by Kolthoff and Lingane (4), is the sulfiteolysis of the protein —S—S— according to the following reaction:



Thus, 1 mole —S—S— yields 1 mole —SH after reaction with sulfite.

One milliliter of an aqueous protein solution, treated with a minute amount of antifoam emulsion (5), is added to 28 ml of 90 percent ethanol containing sufficient  $\text{NH}_4\text{OH}$ ,  $\text{NH}_4\text{NO}_3$ , and ethylenediamine tetraacetate to make the concentrations 0.25, 0.05, and  $3 \times 10^{-5}$  molar, respectively, in a final volume of 31 ml of reaction mixture; 2 ml of cold saturated  $\text{Na}_2\text{SO}_3$  then is stirred into the titration mixture, and the titration with  $10^{-3}M$   $\text{AgNO}_3$  is started immediately.

Quantitative results are obtained only when the reagents are added in the order given, when 90 percent ethyl alcohol is used, and when an excess of  $\text{Na}_2\text{SO}_3$  is present. It is essential that the  $\text{Na}_2\text{SO}_3$  precipitate remain in the titration mixture, since some of the protein is adsorbed on it. This precipitate does not interfere with the titration, provided that the platinum electrode is rotated above the level of the precipitate.



Table 1. Disulfide values in oxidized glutathione, insulin, and prothrombin.

Biological substance	Quantity of biol. substance in titration mixture	10 <sup>-4</sup> M AgNO <sub>3</sub> used in titration (ml)	N per milliliter or milligram of biol. substance (mg)	—S—S— per mole of biol. substance (mole)	
				Our data	Data from literature
Oxidized glutathione*	0.5 mg	0.82		1.00	
	.25 mg	.42		1.03	
	.10 mg	.16		0.98	
	.05 mg	.08		.98	
Insulin†	1.0 ml	.85			2.91‡
	.05 ml	.42	0.268	2.81	2.98‡
	1.0 ml	.21			
	0.5 ml	.11	.066	2.83	
Prothrombin	5.0 mg	.30	.156	3.86	
	2.0 mg	.12	.157	3.86	4.10†
Prothrombin**	0.1 ml	.07	.167	4.06	

\* Nutritional Biochemicals Corp.; calculated on basis of 13.7 percent N.

† Lilly Research Laboratories, T-2842; calculated on basis of 15.55 percent N and mol. wt. 5700.

‡ Harfenist (7); beef insulin, component A.

§ Harfenist (7); beef insulin, component B.

|| Purified bovine prothrombin (Seegers); reconstituted from frozen-dried state; N corrected for 2.42 percent ash.

† Laki et al. (8); calculated from 3.14 g amino acid per 100 g protein expressed as cystine/2 and from mol. wt. 62,700.

\*\* Purified bovine prothrombin (Seegers); thawed from liquid-frozen state; calculated on basis of 15.5 percent N, mol. wt. 62,700.

It is necessary that the Na<sub>2</sub>SO<sub>3</sub> be freshly prepared, cold, and fully saturated, and that it be used within 45 min after preparation. Under the foregoing conditions, —S—S— does not react with Ag<sup>+</sup>. It was observed that higher protein concentrations could be employed in the presence of the antifoam emulsion. Passage of nitrogen through the titration mixture was unnecessary (6). Typical results obtained with the method are shown in Table 1.

Multiple determinations, using variable concentrations, have been made on oxidized glutathione, insulin, prothrombin, thrombin, fibrinogen, and thromboplastin. Recovery of oxidized glutathione was virtually complete when it was added to the proteins used in this work. The results obtained by this method are in

good agreement with those obtained by others on hydrolyzates of insulin (7) and of prothrombin (8).

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9 July 1954.

## Communications

### Few Students Want Culture

Harry J. Fuller's communication [*Science* **120**, 546 (1 Oct. 1954)] reminds me of a day at a public examination for a Ph.D. degree in surgery when the young candidate had reported satisfactorily on much research work on surgery of the stomach. Then a bombshell fell when one of the professors with a historical turn of mind asked who was Dr. W. Beaumont, and the candidate did not know! The professor then asked if he, the young physician, had ever heard of Alexis St. Martin, and he had not. This so upset the committee that the degree was not granted.

After 40 years of teaching medicine to graduates and undergraduates I have the unhappy feeling that most of the men whom I have watched as undergraduates, interns, residents, and graduate students, preparing for a specialty, were not interested in becoming learned and widely experienced and wise. They were interested in getting a certificate of 3 years' attendance that would enable them to take an examination, which, if passed, would give them a listing as a specialist. The less effort used in getting this certificate, the better.

The saddest moment in my teaching life came one day when, going into a library that had been used for half a century by hundreds of graduate medical stu-

dents, I pulled down the copy of Osler's *Aequanimitas and Other Addresses* to get a reference I wanted to quote. What was my shock when I found that this book, published about 1904—this book which since my youth has been to me a source of great spiritual and mental stimulation—had not had its pages cut. It had never been taken out or read!

What can a teacher do with men who have no desire for a wide education?

WALTER C. ALVAREZ

Professor of Medicine Emeritus,  
University of Minnesota (Mayo Foundation)

15 October 1954.

The communication of Harry J. Fuller [*Science* 120, 546 (1954)] regarding the ignorance of the humanities of his candidates for the Ph.D. in biology is of interest. When a course of study is designed to teach a man more and more about less and less, what can one expect?

It is also interesting to note that many scientists, sooner or later, become slightly ashamed of their general ignorance and curtail their scientific work to secure a thin veneer of "culture." A number of years ago a leading medical school in this country went "arty." The faculty went in for oil paintings and water colors, and for years the conversation revolved about art. However, during this period the Art Institute in the same city did not establish any laboratories or carry on any scientific work. I cannot help but feel that what is sauce for the goose should be sauce for the gander.

One of the easiest things in the world to do is to ask a question that another cannot answer. Inability to answer is not necessarily a sign of ignorance.

For generations in England and her colonies it was taken for granted that an educated man was familiar with the Bible, Shakespeare, and Blackstone's *Commentaries*. I am tempted to guess that a considerable number of Ph.D. examiners in science would have trouble passing an examination upon these three, and some would be in the position of never having heard of Blackstone.

The enormous amount of knowledge makes it impossible for any one person to have a speaking acquaintance with but a tiny fraction of it. I doubt that any living man knows 10% percent of the total available knowledge. In truth, we are all ignorant.

WILLIAM H. BELL

Milford, Ohio

11 October 1954.

It is not easy to comment upon Bell's letter because of its seeming inconsistencies. In the first paragraph, Bell appears to agree with my suggestion that perhaps we are teaching too much about less and less; then, in the third paragraph he implies that it is silly of me to ask graduate students questions to determine some-

thing of the extent of their knowledge. Finally, he appears in his statement that "we are all ignorant" to have tossed in the sponge about the whole business of education.

Bell's comments about the asking of questions point up my general thesis, namely, that we are perhaps losing a sense of values in education. Of course, I could stun any doctoral candidate in science into a seeming display of ignorance by asking him the year of Columbus' landing on Martinique or the Empress Josephine's family name. Similarly, a doctoral candidate in the humanities would certainly fold up at a question of the number of cilia on the zoospores of *Ulothrix* or one on the structural formula of indole-3-butyric acid. But the questions that I asked were about major landmarks in the history of human thought and achievement and, as such, were important questions.

Just as Bell appears to have failed to distinguish among the value of different questions, so are we increasingly failing to distinguish among values in education. The end-result of such failure is apparent in the academic chaos demonstrated in the catalogs of some of our universities in which the only courses required of all students are hygiene, physical education, and freshman rhetoric.

HARRY J. FULLER

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15 October 1954.

### Paleontological Identification and Analysis by the Punched-Card Method

An expedient method of identifying fossil remains is of the utmost necessity to paleontology. To foster these returns, the paleontologist has developed many taxonomic keys for tracing down an unknown individual. These morphologic and genetic keys are unwieldy and leave much to be desired. For example, if a worker is doubtful as to what subdivision of the key his specimen belongs or the specimen is poorly preserved and does not show the essential characteristics, the key is of little value. It is useless because the worker has to check a great number of descriptions before he identifies his specimen. This can be eliminated by the use of punched cards. Actually, a punched-card classification presents the worker or student with an almost unlimited number of keys. He makes up the key as he progresses. This type of key has a great deal more value to him, since he may use any characteristic that he chooses to begin and succeeds that characteristic with another outstanding feature of the individual he wishes to identify. The use of punched cards also overcomes the difficulty presented by a broken or poorly preserved specimen in which the properties listed at the beginning of a key are not discernible [R. Casey and J. Perry, *Punched Cards: Their Application to Science and Industry* (Reinhold, New York, 1951)].

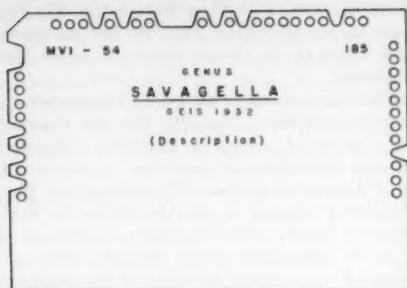


Fig. 1. Punched card of the genus *Savagella*.

Figure 1 depicts the punched card of the genus *Savagella* of the class Ostracoda. There were 48 holes around the edge, 14 of which are shown punched out. Each hole signifies a characteristic of the Ostracoda, and those holes that have been notched show the characteristics of the genus illustrated. Such morphologic criterions as type of hinge, overlap, ornamentation, and dimorphism are included, and the geologic range is also indicated. By using a steel rod and inserting it through a pack of punched generic cards, the cards having the feature picked will fall from the rod. Other diagnostic features may then be used until only a few cards remain, facilitating the identification of the specimen.

I have applied this method toward identifying the ostracods and have utilized statistical data obtained from the cards in analyzing their development during the Paleozoic era [master of science thesis, Michigan State College, 1952]. The evolution of hinge, overlap, and various ornamental aspects may be plotted with respect to geologic time or with one another. This greatly shortens a time-consuming process and allows for a more complete analysis of the factors affecting the Ostracoda.

The use of punched cards for identification and analysis certainly is not limited to micropaleontology or to paleontology in general. This method may be applied to all forms of taxonomic systems and, through the use of punched-card equipment, complete catalogs of classes of organisms could be maintained.

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Magnolia Petroleum Company, Abilene, Texas

16 September 1954.

### A Method for Rapid *in situ* Demonstration of the Thymus and Other Tissues with High Nucleoprotein Content

The importance of considering the thymus as a functional organ throughout life was stressed in a previous communication [V. P. Simmons, *Pediatrics* 5, 574 (1950)]. However, it is seldom seen or recognized today in other than immature laboratory animals or children largely because of the fact that it

blends in so well with the fat that envelops it and because the individual lobules are not always in sufficiently close apposition to provide an easily visualized continuum. This difficulty can be quickly and dramatically overcome by fixing the thymus either *in situ* in an anesthetized animal to show its normal relationships or by removing the contents of the entire thymic area and fixing them *in vitro*. The animal is necessarily sacrificed following either of these procedures. Unfortunately, potent fixatives cannot be applied very readily in the living animal without the functional destruction of tissues vital to existence.

Although other fixatives are also effective, Carnoy's solution (absolute alcohol 6 parts, chloroform 3 parts, and glacial acetic acid 1 part) has been found to be quickest acting and very rapidly penetrating.

The solution can be sprayed or poured on, or the tissues can be removed and immersed in it. Surface fixation is accomplished in seconds; the individual lobules become white and are sharply outlined against the surrounding tissues, which are either fatty or less richly endowed with nucleoprotein (see Figs. 1 and 2). Lymph nodes are quickly fixed in the same manner, but their appearance is so different from that of the

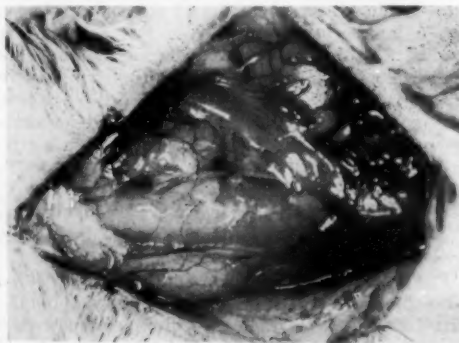


Fig. 1. The normal thymic area exposed in a living, anesthetized male guinea pig weighing 400 g.



Fig. 2. The same area following the application of Carnoy's solution. The thymic tissue appears white.

thymus that difficulty in differentiating the two tissues does not arise; often one can grossly distinguish the surface lymphoid follicles in the nodes.

This work has been supported by a research grant (C-2344) from the National Institutes of Health, Department of Health, Education, and Welfare.

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29 July 1954.

## Plastic Chamber for Inert Atmospheric Work

The determination of physical constants of materials that are sensitive to the atmosphere requires expensive and elaborate equipment. We have designed an inexpensive dry-box that can be used to determine the refractive indices of materials that are oxidized by atmospheric oxygen. To make these determinations, an Abbé refractometer must be enclosed in an atmosphere-tight container having the visibility necessary for efficient operation of the instrument. Commercially available dry-boxes are unsatisfactory for this specialized purpose because of size, cost, visibility, and weight. Polystyrene was used to construct the dry-box shown in Fig. 1 because it would provide the desired properties of the container and retain ease of construction.

A cement made of polystyrene dissolved in trichloroethylene was used to join the component parts,  $\frac{1}{2}$  in. polystyrene base,  $12.5 \times 18$  in.,  $\frac{1}{4}$  in., polystyrene sides,  $9 \times 12$  in. and  $9 \times 18$  in., and 0.01 in. polystyrene top. The water, electric, and nitrogen inlets were sealed with the same cement. The glove ports were made by bending with heat a  $2 \times 17.5$  in. strip of  $\frac{1}{4}$ -in. polystyrene around a pipe. To make bends in the thin polystyrene to form the top, the seams were moistened with trichloroethylene to soften the plastic. Any leaks that may be detected are readily sealed by application of the cement.

The use of this box was found to be quite satisfactory. The refractometer scale could be read with ease through the top, and the box was sufficiently light to

be moved even with the refractometer inside. Some leakage occurred at the glove ports, but this was not critical, if the pressure inside the box was kept greater than atmospheric pressure. A sheet of aluminum foil on the bottom of the box prevented spilled organic liquids from softening the plastic. For the removal of traces of oxygen remaining after sweeping the dry-box with an inert gas, a weighing bottle containing a glass-wool wick saturated with tri-*n*-butylborane, a substance that is readily oxidized, was opened. Materials were introduced into and removed from the dry-box through the glove ports.

With slight adaptations the box could be used for containing other pieces of apparatus or for work in an anhydrous atmosphere.

I wish to express appreciation for the technical assistance of Helmut Haendler and Walter Eldredge and for advice received from the Plax Corporation of Hartford, Connecticut.

ROBERT E. LYLE

*Department of Chemistry,  
University of New Hampshire, Durham*

24 September 1954.

## On Column Chromatography of Sugars

The use of carbon (1) and cellulose (2) columns has become widespread for the separation of carbohydrates of comparatively low molecular weight. It is therefore desirable to point out several factors of importance in the general use of such columns.

When using carbon columns made of any of a variety of charcoals, we have found it expedient to give the column a preliminary wash with dilute hydrochloric acid solution in order to assure the removal of basic ash, which might otherwise cause some isomerization of the sugars applied later. A 1 percent hydrochloric acid solution is sufficient. The acid is then removed from the column by washing with distilled water. Celite (3) is usually mixed with finely ground charcoals (4) to increase flow rate. However, celite sometimes dissolves in the developing solutions and is obtained as a flocculent precipitate in the concentrated effluence. Celite can be removed from the concentrated effluence by filtration through a bacterial filter or by evaporation of the solution to dryness and redissolution of the carbohydrate in water. To avoid this inconvenience we often use columns composed entirely of charcoal. The charcoal selected is that which passes a 40- or 60-mesh screen but is retained on an 80-mesh screen. This produces a column composed entirely of charcoal and consequently increases sorptive capacity of the column.

Often in the use of cellulose columns, carbohydrates other than those placed on the columns are observed in the eluates. These extraneous carbohydrates arise from the cellulose or disintegrated filter paper employed to pack the column. The cellulose used is, of course, not chemically pure but represents a purified pulp that still contains a small amount of hemicellu-

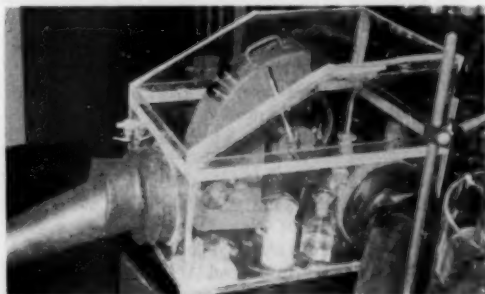


Fig. 1. An apparatus for determining refractive indices in an oxygen-free atmosphere.



lose. These extraneous carbohydrate substances are most often observed in the initial column effluent, particularly if water is passed through the column. Extraneous carbohydrates are also sometimes encountered in later effluents when liquids other than pure water are used. To reduce the amounts of these extraneous substances, it is suggested that cellulose columns be given a preliminary washing with water before use. While we presently know of no way to prevent completely the elution of extraneous substances from cellulose columns, we wish to call attention to their presence.

In operating chromatographic columns, particularly those of considerable length, it is desirable to apply positive pressure at the head rather than suction on the effluent. Application of vacuum often causes the lower portion of the column to be partially freed of solvent with consequent poor separations in these regions.

There seem to be two schools of thought concerning whether columns should be packed dry or by the slurry method. In our experience either method is good when properly handled. In packing by the slurry method care must be taken to use a thick slurry and thus prevent fractional separation of particle size or, in the case of a carbon-celite mixture, separations of the two components.

ROY L. WHISTLER

Department of Biochemistry, Purdue University,  
Lafayette, Indiana

#### References and Notes

1. R. L. Whistler and D. F. Durso, *J. Am. Chem. Soc.* **72**, 677 (1950).
2. L. Hough, J. K. N. Jones, and W. H. Wadman, *Nature* **162**, 448 (1948).
3. Celite No. 535, a product of Johns-Manville Co., New York, N.Y.
4. Such as Darco G-60, a product of Darco Corp., New York, N.Y.

14 October 1954.

### Experimental Arteriosclerosis; Sulfur or Choline Deficiency?

A description of a kind of vascular abnormality produced in young rats by dietary means has been described by Wilgram, Hartroft, and Best (1). The authors attribute these arterial effects to a deficiency of choline, although the diets employed were profoundly deficient in essential organic sulfur compounds as well. Mortalities of 50 and 75 percent of the experimental groups in the 28-day periods of observation attest to the rigors of the diet. These experiments should be considered in relation to the chronicity of arteriosclerosis toward which all such experimentation is ultimately directed.

In their discussion the authors mistakenly observe, when referring to our work with experimental atherosclerosis in *Cebus* monkeys, that we have not specifically investigated the effects of choline deficiency on the vessels of monkeys. We have, in fact, done this and our observations were described (2). It was found

that choline deficiency effectively prevented sufficient hypercholesterolemia to produce atherosclerosis in the monkeys. I believe that is because the animals became ill and refused to eat.

Our most atherogenic diets regularly contain 0.5 percent choline. We also observed (2) that this disease in monkeys is either prevented or cured with L-cystine and this effect has since been extended to several congeners of cystine with similar effects (3). It is perhaps of interest to those who press for the importance of choline in a variety of ailments that our discovery of the relationship of sulfur metabolism to atherosclerosis in monkeys resulted from the great difficulty we experienced in producing evidences of choline deficiency in this primate species.

Finally, Wilgram *et al.* propose that the much abused term *lipotropic* be extended to still another poorly understood phenomenon: the prevention of the accumulation of lipids in blood vessel walls. This redefinition of the term can scarcely do more than add to the existing confusion. The variety of meanings of *lipotropic* both in respect to anatomical structures involved and to the methods known or presumed to have induced the lipid deposition will require a short qualifying paragraph for each context in which the term is used.

It is well known that if a hungry cat consumes a saucer of cream, it will shortly show an accumulation of lipids both in its intestinal mucosa and in its liver. Are we to apply the term *lipotropic* to a milkman who does not come, to a more aggressive cat, or even to the large mouse that may have already satiated the cat? This proposal surely defeats the purposes of language.

GEORGE V. MANN

Department of Nutrition,  
Harvard School of Public Health,  
Boston, Massachusetts

#### References

1. G. F. Wilgram, W. S. Hartroft, and C. H. Best, *Science* **119**, 842 (1954).
2. G. V. Mann *et al.*, *J. Exptl. Med.* **98**, 195 (1953).
3. G. V. Mann *et al.*, unpublished data.

5 August 1954.

We have had little experience with *Cebus* monkeys but are now starting an investigation of the role of various dietary factors in the production of atheromatous lesions in small primates. George V. Mann's previous studies have been of great help to us in planning this work. His present letter has raised several interesting points on which we would like to comment.

In the first place, Mann is discussing atherosclerotic lesions seen in monkeys that have been consuming diets high in cholesterol; we have described aortic medial sclerosis produced in rats by diets low in choline and essentially free from cholesterol.

He states that we attribute arterial lesions in choline-deficient rats "... to a deficiency of choline, although the diets employed were profoundly deficient

in essential organic sulfur compounds as well." Our hypolipotropic basal ration was designed to be as complete as possible with respect to essential amino acids while being *relatively* as low as possible in methionine. This diet contained 30 percent of alcohol-extracted peanut meal (about 50 percent protein), 10 percent of casein, and 5 percent of Alpha (soya) protein, giving 30 percent of protein; the total methionine of such a diet is about 520 mg, cystine is 340 mg, and amino-acid sulphur is just over 200 mg per 100 g of ration. Alpha protein at the 20-percent dietary level supplies about 200 mg methionine and less than 100 mg of sulfur. Despite the consumption by our rats of a diet containing more than twice as much methionine and organic sulfur as in the basal rations fed by Mann, they still developed aortic lesions.

We attributed the arterial effects in our experiments to choline deficiency because (i) the diets were known to be low in choline, and (ii) addition of choline to the basal diet consumed by control rats completely prevented development of lesions. The controls consumed amounts of the choline-supplemented diets comparable to the daily intake by the experimental animals of the basal choline-deficient diet. Controls did not receive any organic sulfur compounds other than those consumed by the experimental group. Therefore, in our experiments, the lesions in rats are clearly attributable to choline deficiency rather than to organic sulfur deficiency.

Mann says that our "... experiments should be considered in relation to the chronicity of arteriosclerosis toward which all such experimentation is ultimately directed" and draws attention to the rigors of our dietary regimen. The diets we employed were severely hypolipotropic, because they were designed to produce *acute* lesions *rapidly*. Less rigorous dietary regimens of the same type also produce in rats vascular lesions of the chronicity that Mann apparently desires. Experiments of this type were previously reported from our laboratories in 1952 [*Proc. Soc. Exptl. Biol. and Med.* 81, 384 (1952)], incidentally antedating Mann's publications in this field [*J. Exptl. Med.* 98, 195 (1933)]. The diets that we employed in the chronic type of experiment could be regarded as more "physiological" than those in the acute. Acute experiments are sometimes desirable, however, to speed up the progress of investigations of this type. The arterial lesions produced by both methods are identical, differing only in degree.

Mann states that they experienced "great difficulty ... in producing evidences of choline deficiency in this primate species," and yet his paper contains several references to the fatty livers and poor condition of monkeys not given choline supplements. Surely his own data suggest that dietary choline (or its precursors including methionine) is necessary to maintain life of primates and that it is almost too easy to produce evidences of lack of adequate dietary choline in monkeys.

His own experiments elucidate to some degree the role of dietary choline in protecting the cardiovascular

system of monkeys. We could find specific references in his paper to autopsy studies of only three monkeys (his numbers 1-6, 3-0, 3-2) that had been fed a hypolipotropic diet (low choline and low methionine, with 5 percent added cholesterol). Of these three animals two "showed minimal aortic lesions." These lesions had developed within 3 to 11 wk (average 7 wk) of dietary deficiency, despite the fact that the authors state "In the absence of choline animals had poor appetites, grew poorly and died with fatty livers." It is generally accepted that inadequate food intake will inhibit the development of lesions due to a deficiency of any vitamin or essential food factor. Therefore, in view of the relatively brief period of dietary deficiency and the poor food intake, we think it highly significant that under these conditions two or three monkeys developed even "minimal aortic lesions." Furthermore, seven control animals fed similar diets without added *DL*-methionine, but with 0.5 percent choline (see his Table VII) were free from aortic lesions. This series of 10 animals would indicate then that supplementary choline prevented lesions that otherwise developed in the experimental animals. His data with primates corresponds to ours obtained with rats in 1952.

Mann claims to have obtained a higher incidence of lesions in monkeys fed low-methionine, choline-supplemented diets containing 5 percent cholesterol. The total number of animals employed was greater but the *percentage-incidence* of lesions in this group was actually lower. These monkeys were observed for longer periods than were the choline-deficient group—for example, monkey No. 4-1 (from which *all* of Mann's photomicrographs were taken) was fed this diet for 25 wk. Of 17 monkeys in this group, eight developed aortic lesions demonstrable at autopsy; an incidence of less than 50 percent in these animals compared with 66 percent (two out of three) in the choline-deficient group. With such small numbers of animals, these differences may be of limited significance.

Mann found "that choline deficiency effectively *prevented* [his italics] sufficient hypercholesterolemia to produce atherosclerosis in the monkeys." But his own data show that in the absence of choline and *absence of hypercholesterolemia*, two of three animals did develop atherosclerosis. We reported [*Science* 119, 842 (1954)] that choline-deficient rats fed diets *without* added cholesterol developed medial aortic lesions preventable by choline supplements. The choline-deficient rats had *lower* levels of serum cholesterol than the choline-supplemented controls. Therefore, under some conditions at least (two out of three of Mann's choline-deficient monkeys and in our experiments with rats referred to in foregoing paragraphs) aortic lesions developed without elevated levels of serum cholesterol. Therefore, we believe that the statement of Mann's quoted at the beginning of this paragraph needs some further support.

It should be noted that, to induce the atherosclerotic lesion in monkeys by use of diets high in cholesterol, a large intake of food appears necessary. To insure

adequate food intake it is essential to have choline in the diet, as Mann found. The aortic lesion we described, which does not require a sustained high food intake and which is prevented by choline, has a completely different pathogenesis.

Mann challenges our right and wisdom in broadening the meaning of the term *lipotropic*. We are most anxious to preserve the clarity of the term which one of us introduced. If choline deficiency leads to abnormal changes in liver, kidney, heart, and vessels that are preventable by adequate supplements with lipotropic agents (as the evidence published from this laboratory and from others now clearly indicates), we fail to see why the term should continue to be limited to the effects of deficiency on only one of these organs. Had the need for lipotropic substances in maintaining kidneys, hearts, and vessels been discovered at the same time as their need for maintaining the liver, Mann would probably not have objected to the broad concept we now propose for the term *lipotropic*. His objection is obviously based on the fact that these various manifestations of choline deficiency were discovered at different times. The proper designations for tardy milkmen and aggressive cats we prefer to leave to Mann's imagination.

Whether similar sclerotic lesions are under consideration and whether sulfur or choline is more important will require further careful experimentation. Interchange of data between responsible investigators will eventually provide the true answers, which may be quite different from Mann's present ideas or from ours.

GEORGE F. WILGRAM  
W. STANLEY HARTROFT  
CHARLES H. BEST

*Banting and Best Department of Medical Research,  
The Charles H. Best Institute,  
University of Toronto, Toronto, Canada*

7 October 1954.

### Potential Application of Community Censuses and Genealogies

I have been thinking that anthropologists whose records contain answers to two questions could help make possible some theoretical estimates of rates of

ongoing evolution. These questions are: (i) How many people are there in the endogamous group? (ii) What proportion of individuals enter the group from without?

As I have pointed out ["Mixture and genetic drift in ongoing human evolution," *Am. Anthropol.* 54, 433 (1952)], evolution has been defined as a change in gene frequencies. Gene frequencies change in response to a small number of factors: natural selection, mutation, admixture, and chance variation from one generation to the next. If ethnographers will provide answers to the two questions for a number of groups with a variety of cultures, one could calculate rates of admixture and chance variation. Under assumptions about mutation and natural selection, one could then estimate possible rates of evolution without any reference to the fossil record.

The minimum information necessary to estimate rates of accidental variations in gene frequency is a count of the total population of the endogamous group (be it community, tribe, or caste). In addition one would like to know, if possible, the proportion who are of reproductive age and status and the variation in number of offspring; that is, how many children survive to adulthood for each individual who completes procreation.

The minimum information necessary for a crude measure of admixture is the proportion of persons in the group who were born outside of it. A more useful form of the information is the tabulation of birthplaces of parents of all persons born in the group.

Many anthropologists have made a census or recorded genealogies. These have been preludes to other studies and are frequently unpublished or inadequately presented for the present purpose. However, some readers may be able to add another case. We do not even know yet whether human evolution would have been more rapid before cultivation of the land began. Perhaps we can at least find out to what extent, if any, hunters live in smaller more isolated reproducing groups than, for instance, agriculturalists.

GABRIEL LASKER

*Wayne University College of Medicine,  
Detroit 7, Michigan*

20 September 1954.

*I know nothing more deadening to original ideas than keeping a man's nose firmly fixed to the grindstone. Even directors need a change, and young men should have opportunities of meeting other young men working in other parts of the country. Ideas are more likely to come from such meetings with colleagues than by holding men down to some work in which there might be no progress at all. No laboratory today is self-sufficing.—Lord Rutherford.*



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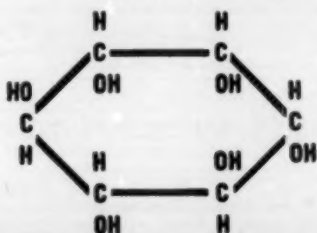
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- 26-30. Inst. of Mathematical Statistics, Berkeley, Calif. (K. J. Arnold, Dept. of Mathematics, Michigan State College, E. Lansing.)
- 26-31. AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, annual, Berkeley, Calif. (R. L. Taylor, 1515 Massachusetts Ave., NW, Washington 5.)
- 26-31. American Nature Study Soc., Berkeley, Calif. (H. B. Ross, State Teachers College, Fitchburg, Mass.)
- 27. Metric Assoc., Washington, D.C. (V. G. Shinkle, 1916 Eye St., NW, Washington 6.)
- 27-28. American Folklore Soc., New York, N.Y. (M. Leach, Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)
- 27-28. Ecological Soc. of America, Berkeley, Calif. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)
- 27-29. American Mathematical Soc., annual, Pittsburgh, Pa. (E. G. Begle, AMS, Yale University, New Haven, Conn.)
- 27-29. Arctic Inst. of North America, Berkeley, Calif. (R. C. Wallace, 4 Centre St., Kingston, Ont., Canada.)
- 27-29. Astronomical Soc. of the Pacific, Berkeley, Calif. (S. Einarsson, Lensehner Observatory, Univ. of California, Berkeley 4.)
- 27-29. International Conf. on Animal Venoms, Berkeley, Calif. (N. Porges, Eastern Regional Research Laboratory at Wyndmoor, Philadelphia, Pa.)
- 27-29. Soc. for Industrial and Applied Mathematics, 1st, Pittsburgh, Pa. (H. W. Kuhn, Dalton Hall, Bryn Mawr College, Bryn Mawr, Pa.)
- 27-29. Western Soc. of Naturalists, Berkeley, Calif. (J. L. Mohr, Univ. of Southern California, Los Angeles 7.)
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6. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
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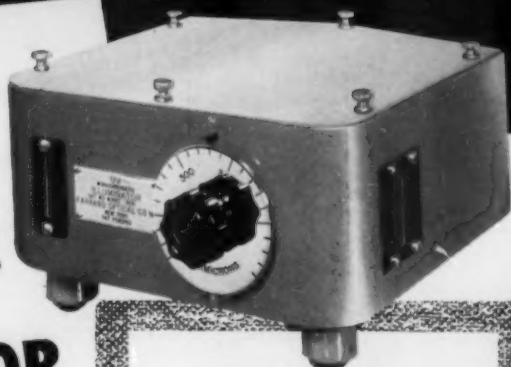
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